PHOTOMICROGRAPHS OF CRYSTALLIZABLE CHEMICAL SALTS

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PHOTOMICROGRAPHS OF CRYSTALLIZABLE CHEMICAL SALTS

BY

ARTHUR W. DOUBLEDAY

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1916

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PREFACE

THE Photomicrographs shown between these covers were made as one of the steps in an endeavor to work out a method of determining the crystallizable chemical salts found in evaporated saliva, during a salivary diagnosis, by means of microscopical comparison of known salts, evaporated from known chemical solutions, with the unknown salts as found in the evaporated saliva.

An expression of gratitude is here extended to Edward C. Kirk, D.D.S., Sc.D., LL.D., The Thomas W. Evans Museum and Dental Institute School of Dentistry, University of Pennsylvania; the late Dr. Joseph Porter Michaels, Paris, France; Dr. Henry Clay Ferris, New York City; Dr. Robert R. Andrews, Cambridge, Massachusetts, and H. Carlton Smith, Ph.G., Harvard Medical College, for their encouragement during this work.

ARTHUR W. DOUBLEDAY.

Boston, Massachusetts, 1916.

FOREWORD

In compiling these photomicrographs no attempt has been made to exhaust the possible chemical combinations, but rather to present typical crystalline forms of various salts, known to exist in the body tissues and fluids under normal and pathological conditions, thereby placing at the disposal of the student of research auxiliary help toward the characteristics which confront him through the microscope.

The magnification is ×100 diameters except when "High Power" is mentioned, indicating magnification of ×430 diameters.

Arthur W. Doubleday.

ERRATA

Plate II, Figs. 1 and 2, CaCl, should be $CaCl_2$.
Plate II, Fig. 2, $H(NH_4)_2CO_3$, should be NH_4HCO_3.
Plate III, Fig. 1, $H(NH_4)_2CO_3$, should be NH_4HCO_3.
Plate III, Fig. 2, NH_4CO_3, should be $(NH_4)_2CO_3$.
Plate IV, Fig. 1, NH_4CO_3, should be $(NH_4)_2CO_3$.
Plate XII, Fig. 2, $NaPO_4$ should be Na_2HPO_4.
Plate XXI, Fig. 2, $MgPO_4$, should be $Mg_3(PO_4)$.
Plate XXIV, Fig. 2, $NH_4C_2O_4$, should be $(NH_4)_2C_2O_4$.
Plate XXV, Figs. 1 and 2, NaC_2O_4, should be $Na_2C_2O_4$.
Plate XXXIV, Fig. 2, $C_{12}H_{24}O_{12}$, should be $C_{12}H_{22}O_{11}$.

PLATE I

Fig. 1. Ammonium Chloride. NH_4Cl.
(Reaction of $NH_4OH+HCl$.)

Fig. 2. Ammonium Chloride. NH_4Cl.
(Reaction of $(NH_4)NO_3+NaCl$.)

PLATE I

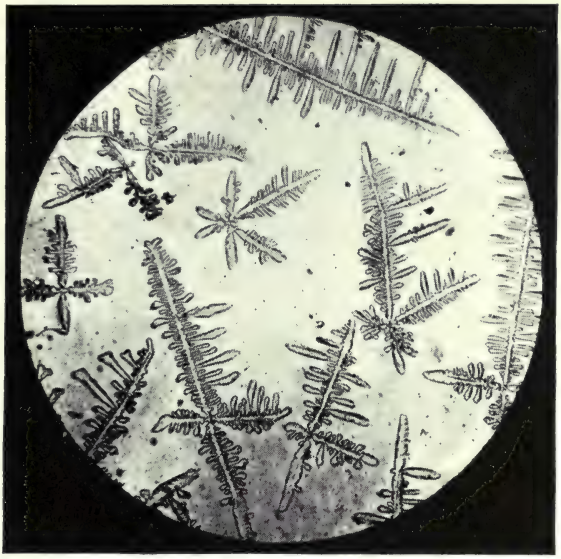


Fig. 1

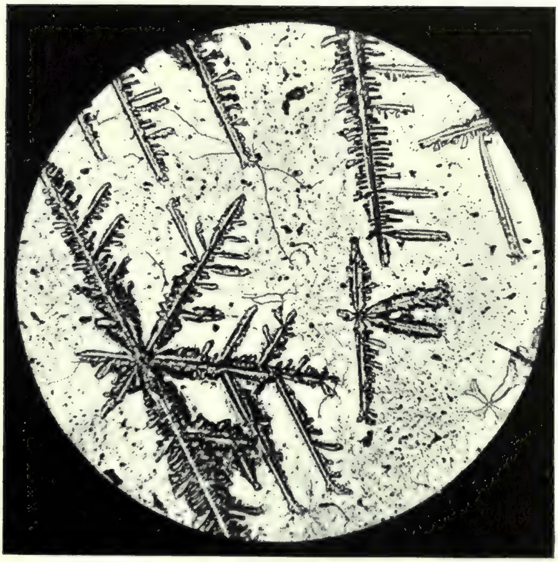


Fig. 2

PLATE II

FIG. 1. Ammonium Chloride. NH_4Cl.
(Reaction of $(NH_4)NO_3+CaCl$.)

FIG. 2. Ammonium Chloride. NH_4Cl.
(Reaction of $H(NH_4)_2CO_3+CaCl$.)

PLATE II

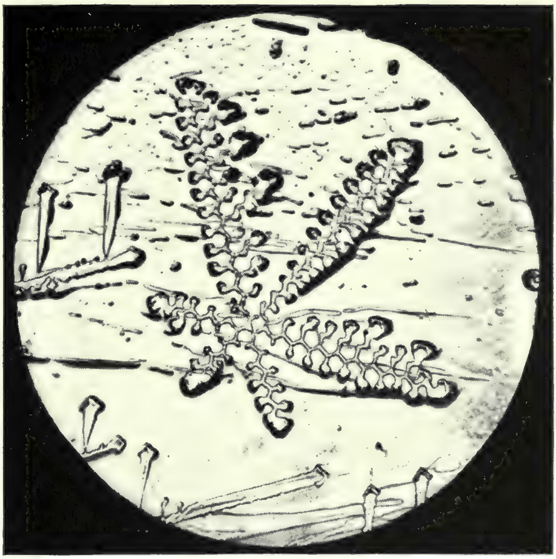


FIG. 1

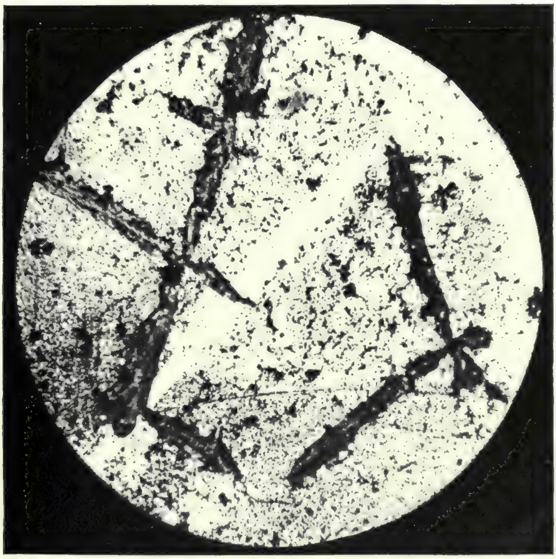


FIG. 2

PLATE III

FIG. 1. Ammonium Chloride. NH_4Cl.
(Reaction of $H(NH_4)_2CO_3 + MgCl_2$.)

FIG. 2. Ammonium Chloride. NH_4Cl.
(Reaction of $NH_4CO_3 + NaCl$.)

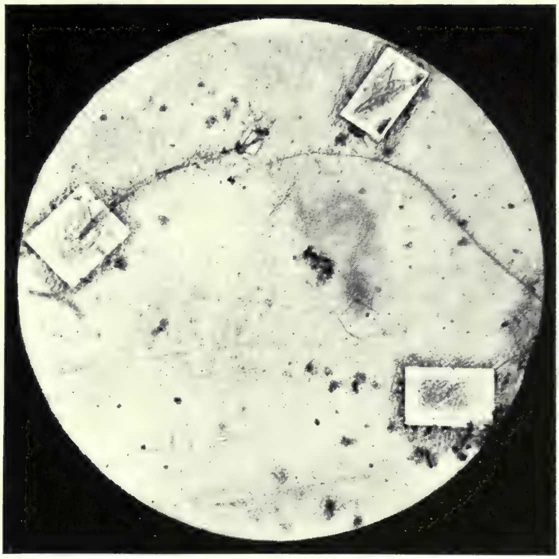


Fig. 1

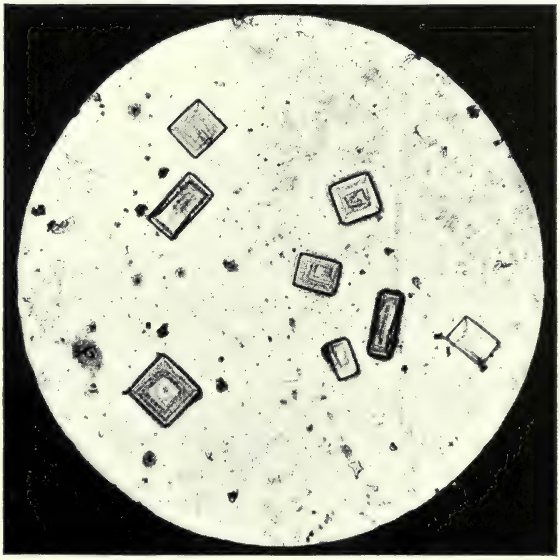


Fig. 2

PLATE IV

Fig. 1. Ammonium Chloride. NH_4Cl.
(Reaction of $NH_4CO_3 + NaCl$.)

Fig. 2. Barium Chloride.

PLATE IV

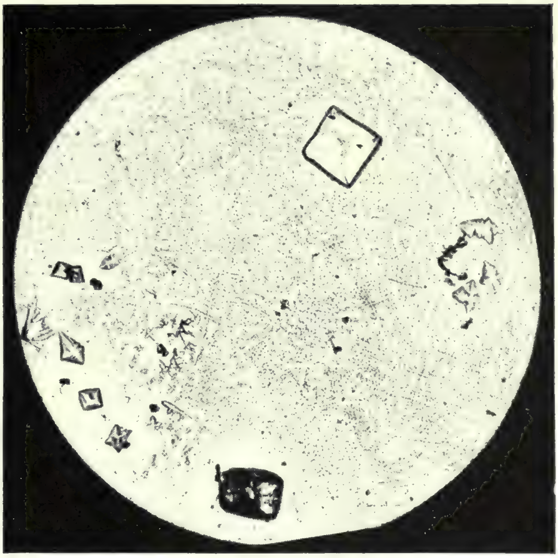


Fig. 1

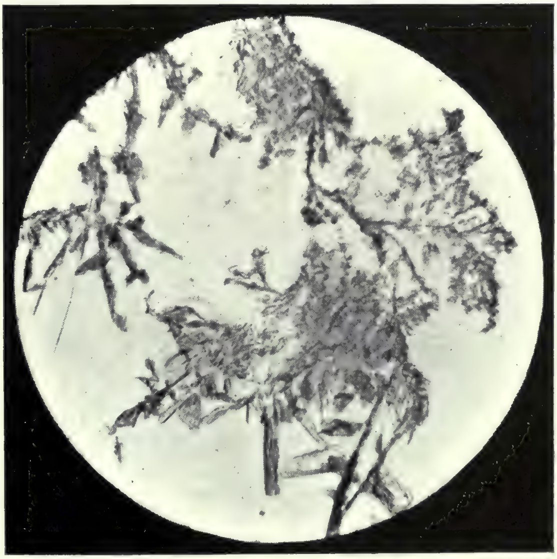


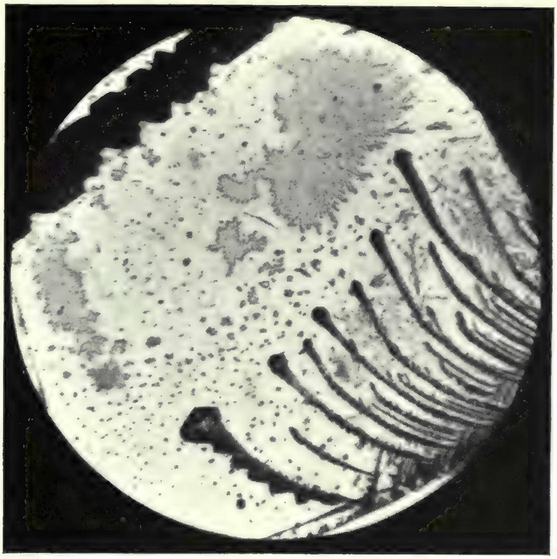
Fig. 2

PLATE V

Fig. 1. Mercuric Chloride. $HgCl_2$.
(Corrosive Sublimate.)

Fig. 2. Mercuric Chloride. $HgCl_2$.

PLATE V



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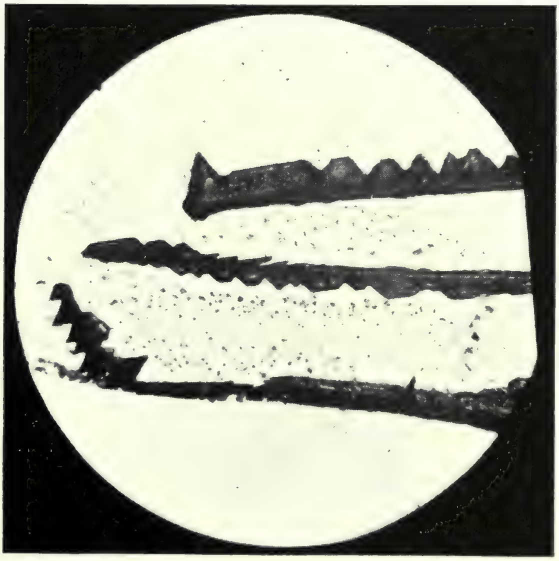


Fig. 2

PLATE VI

Fig. 1. Mercurous Chloride. $(Hg_2)Cl_2$.
(Calomel.)

Fig. 2. Mercurous Chloride. $(Hg_2)Cl_2$.

PLATE VI

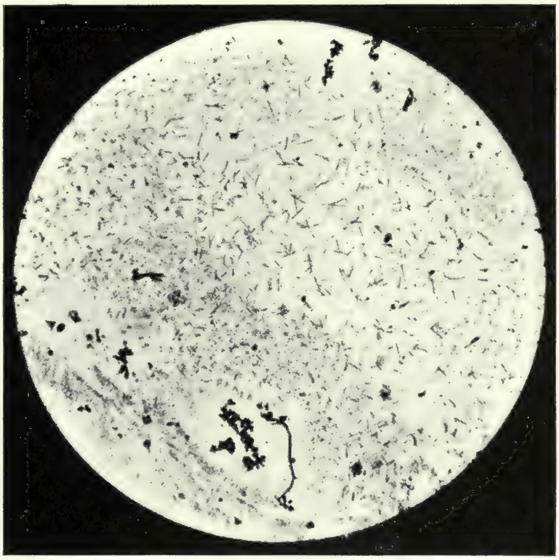


Fig. 1

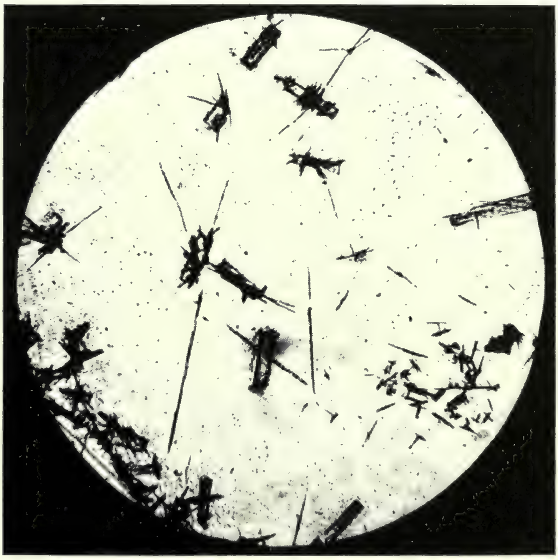


Fig. 2

PLATE VII

Fig. 1. Potassium Chloride. KCl.

Fig. 2. Potassium Chloride. KCl.

PLATE VII

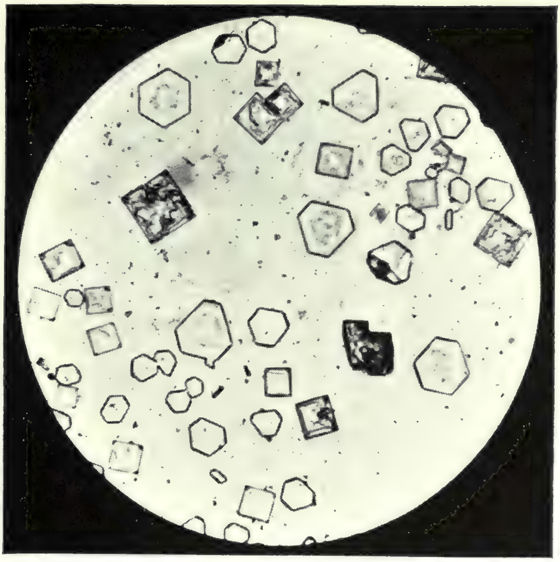


Fig. 1

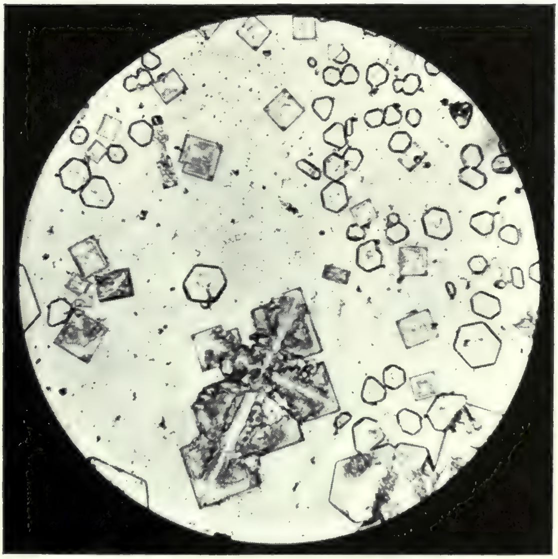


Fig. 2

PLATE VIII

Fig. 1. Potassium Chloride. KCl.

Fig. 2. Potassium Chloride. KCl.

PLATE VIII

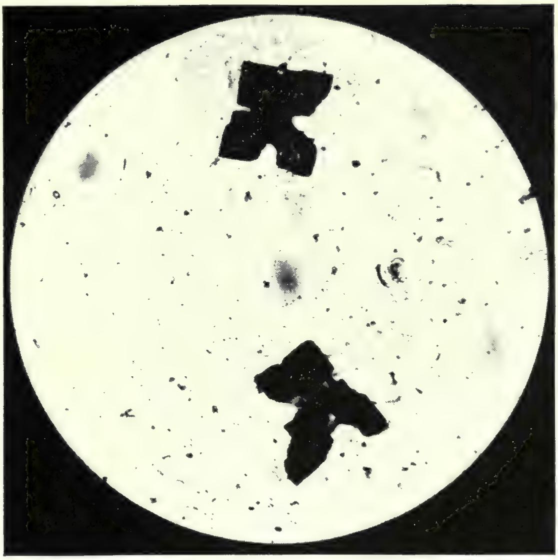


FIG. 1

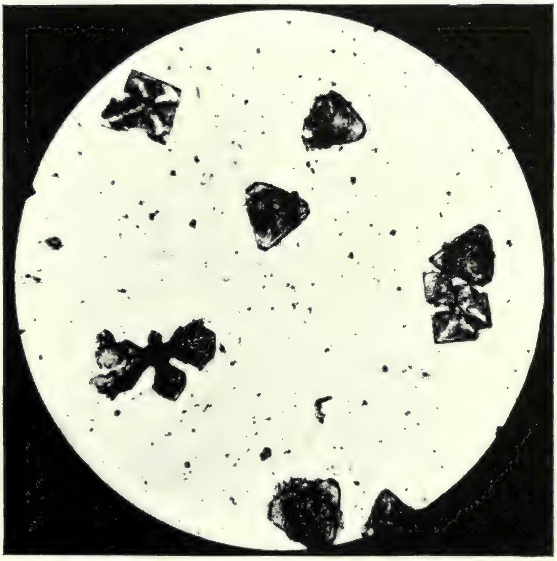


FIG. 2

PLATE IX

Fig. 1. Potassium Chloride. KCl.

Fig. 2. Potassium Chloride. KCl.

PLATE IX

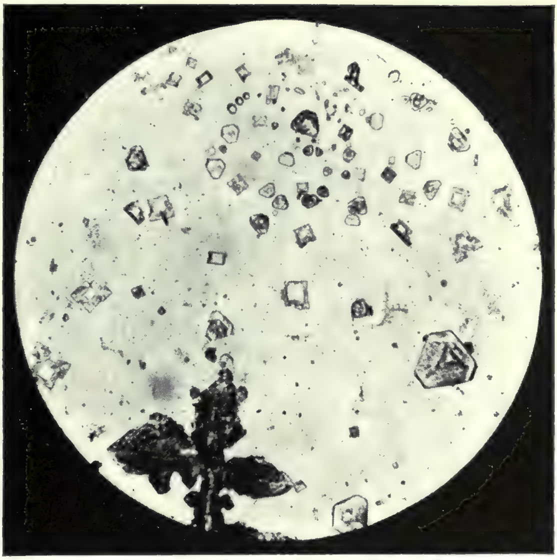


FIG. 1

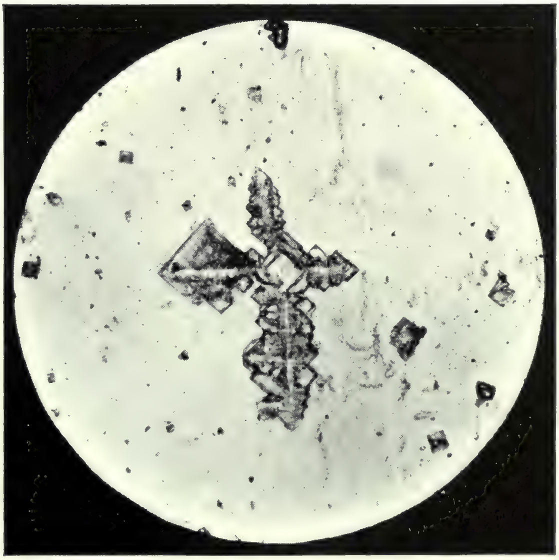


FIG. 2

PLATE X

FIG. 1. Potassium Chloride. KCl.

FIG. 2. Potassium Chloride. KCl.

PLATE X

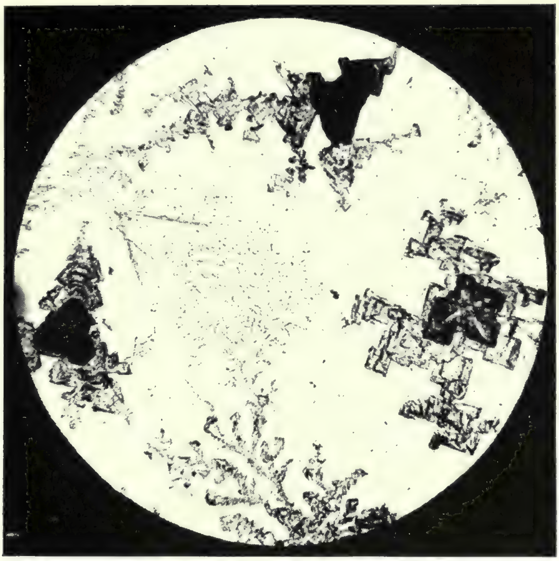


Fig. 1

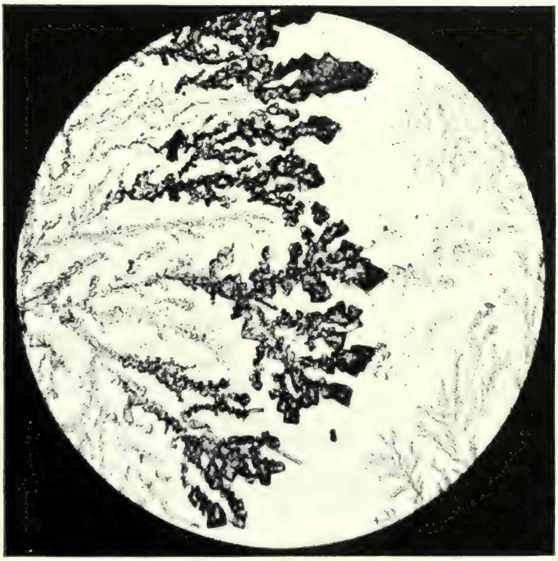


Fig. 2

PLATE XI

FIG. 1. Potassium Chloride. KCl.
(Reaction of $K_2SO_4 + NaCl$.)

FIG. 2. Sodium Chloride. NaCl.

PLATE XI

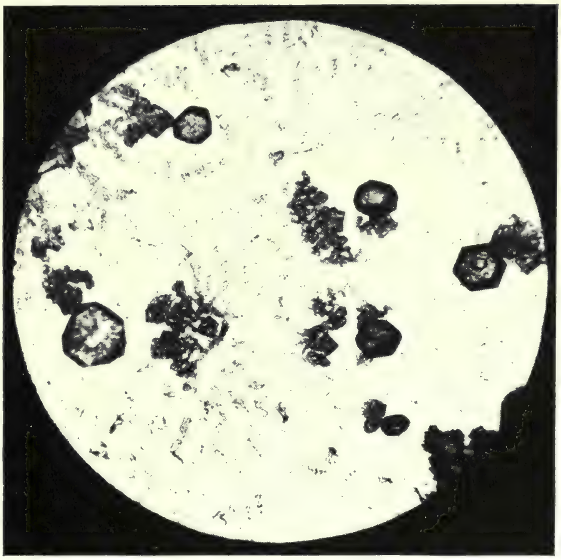


Fig. 1

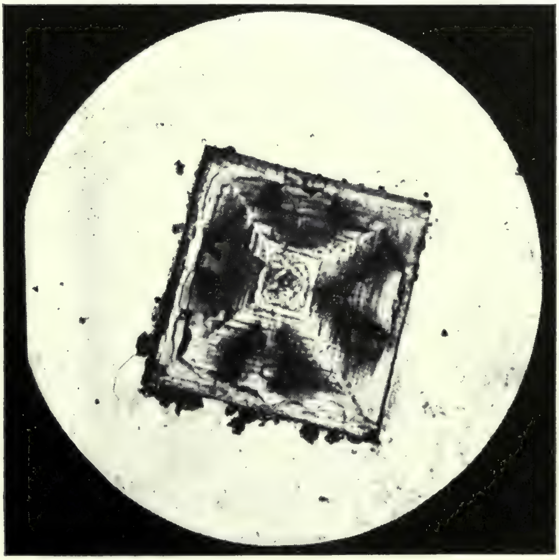


Fig. 2

PLATE XII

Fig. 1. Sodium Chloride. $NaCl$.
(Reaction of $NaHCO_3 + NH_4Cl$.)

Fig. 2. Sodium Chloride. $NaCl$.
(Reaction of $NaPO_4 + NH_4Cl$.)

PLATE XII

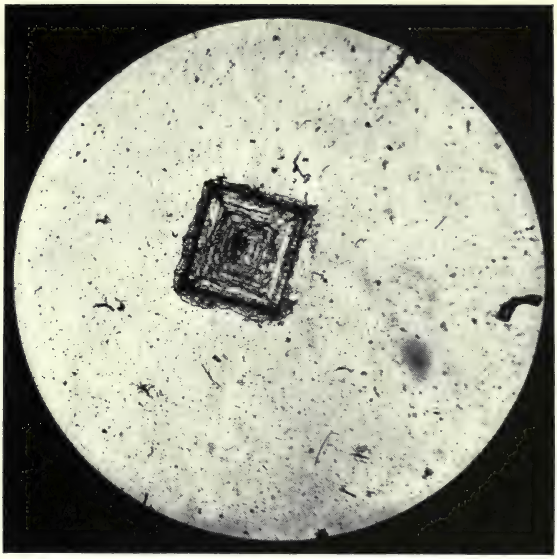


Fig. 1

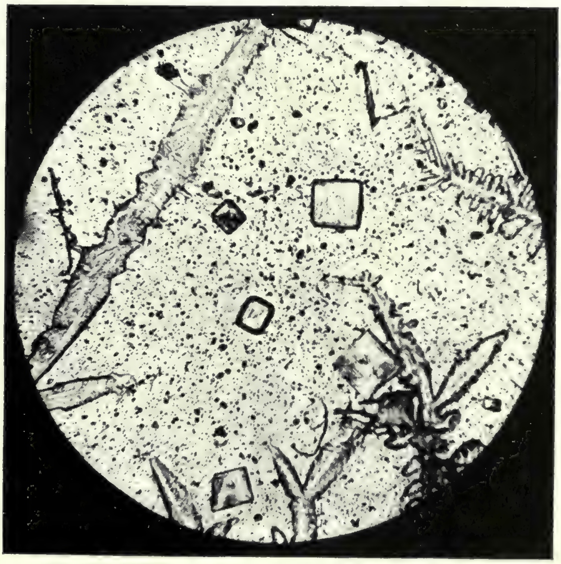


Fig. 2

PLATE XIII

Fig. 1. Ammonium Sulphate. $(NH_4)_2SO_4$.

Fig. 2. Ammonium Sulphate. $(NH_4)_2SO_4$.

PLATE XIII

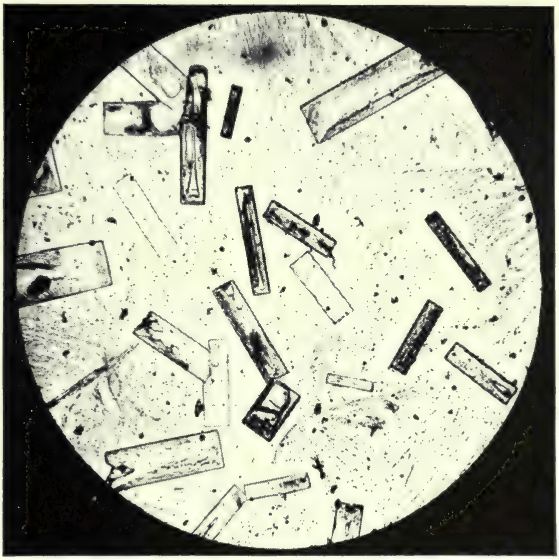


Fig. 1

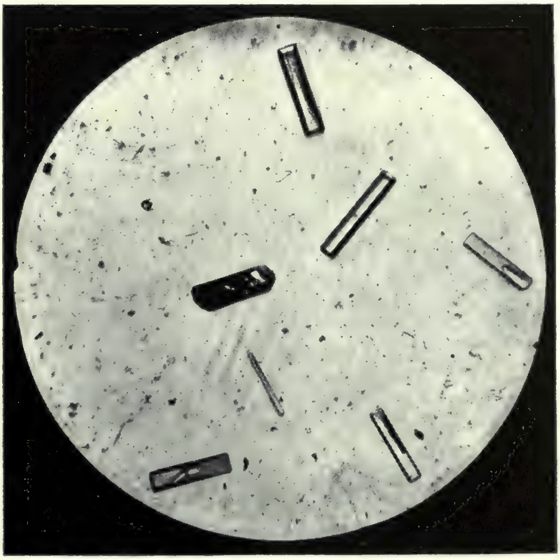


Fig. 2

PLATE XIV

Fig. 1. Potassium Sulphate. K_2SO_4.

Fig. 2. Potassium Sulphate. K_2SO_4.

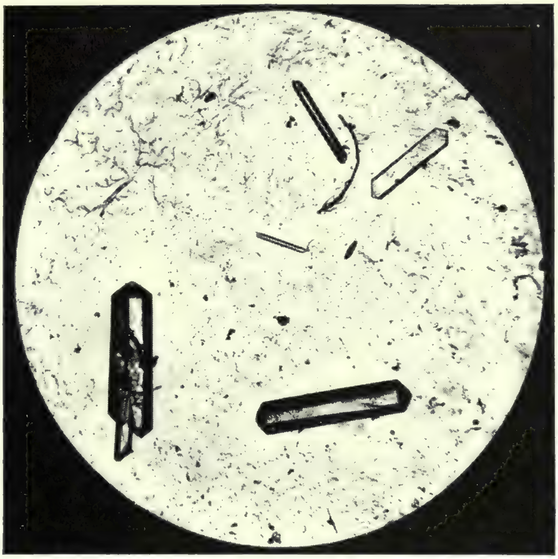


FIG. 1

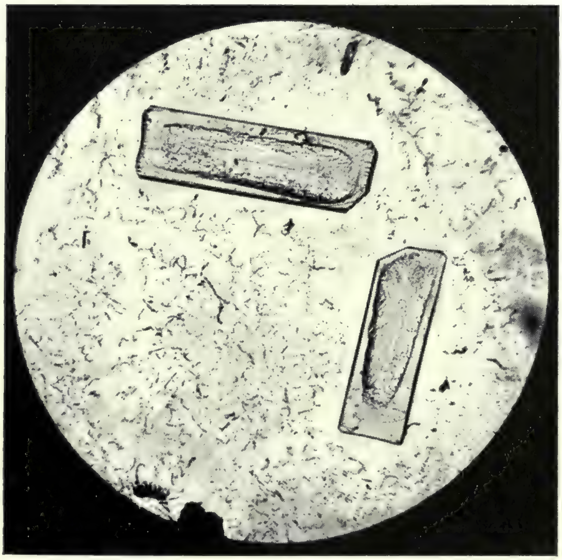


FIG. 2

PLATE XV

Fig. 1. Acid Potassium Sulphate. $KHSO_4$.

Fig. 2. Calcium Sulphate. $CaSO_4$.

PLATE XV

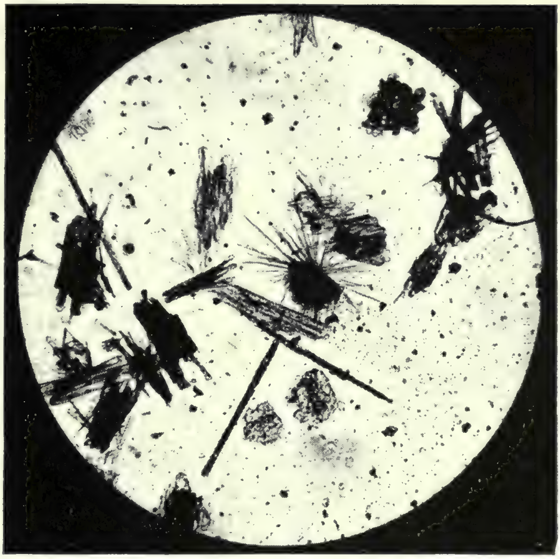


FIG. 1

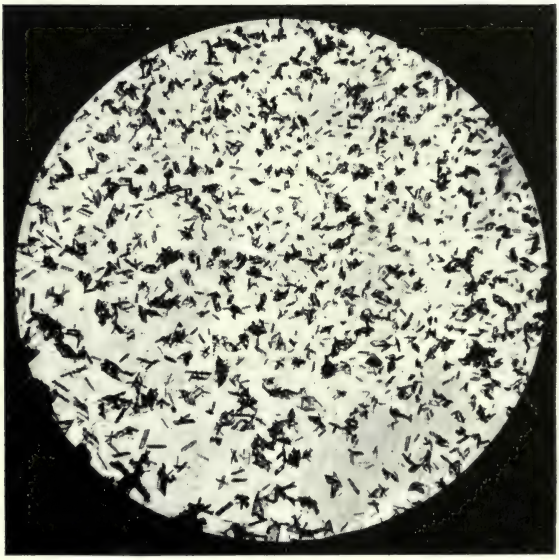


FIG. 2

PLATE XVI

Fig. 1. Magnesium Sulphate. $MgSO_4$.

Fig. 2. Ammonium-Magnesium Sulphate.

PLATE XVI

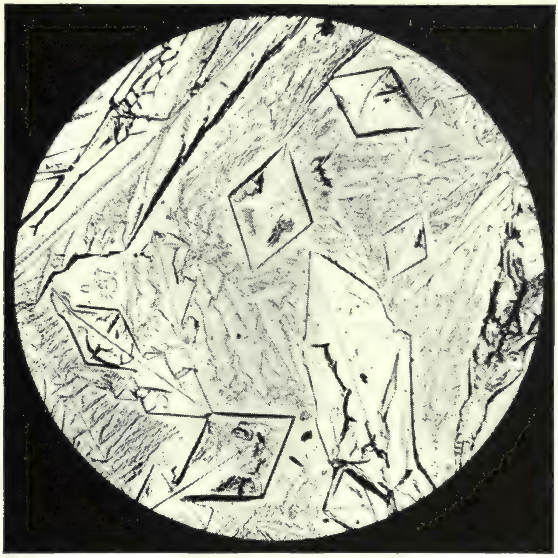


FIG. 1

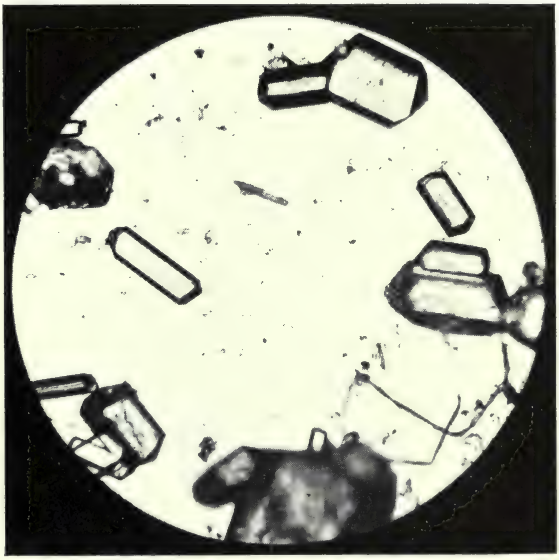


FIG. 2

PLATE XVII

Fig. 1. Sodium Sulphate. Na_2SO_4.
(Glauber's Salt.)

Fig. 2. Sodium Sulphate. Na_2SO_4.

PLATE XVII

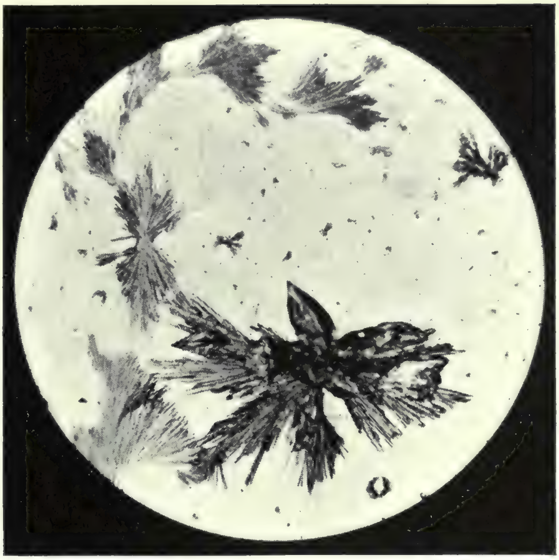


FIG. 1

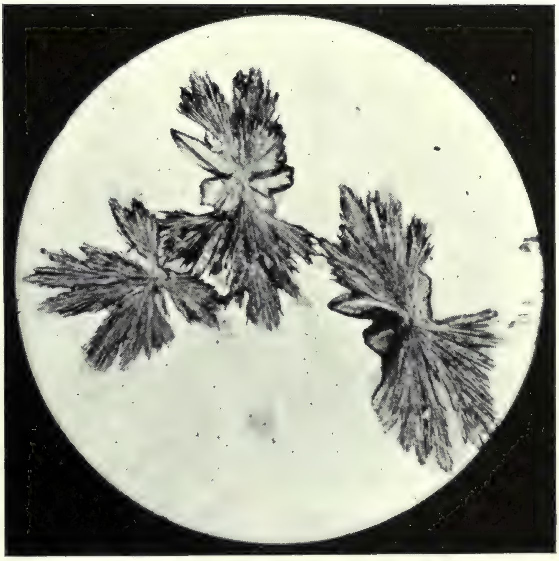


FIG. 2

PLATE XVIII

Fig. 1. Ammonio-Magnesium Phosphate. $(NH_4)MgPO_4$.
(Triple Phosphate.)

Fig. 2. Ammonio-Magnesium Phosphate. $(NH_4)MgPO_4$.
(Triple Phosphate.)

PLATE XVIII

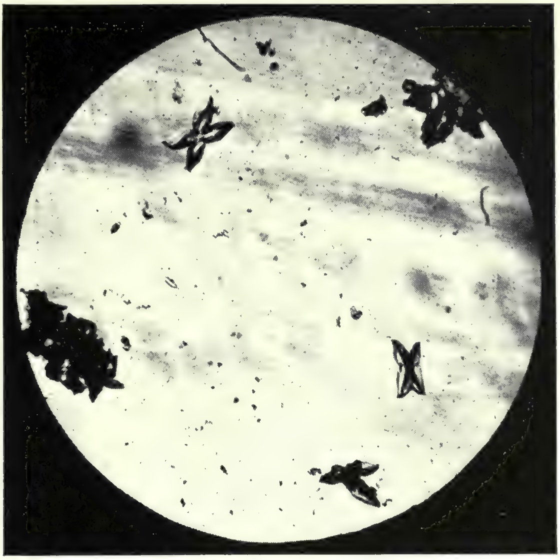


FIG. 1

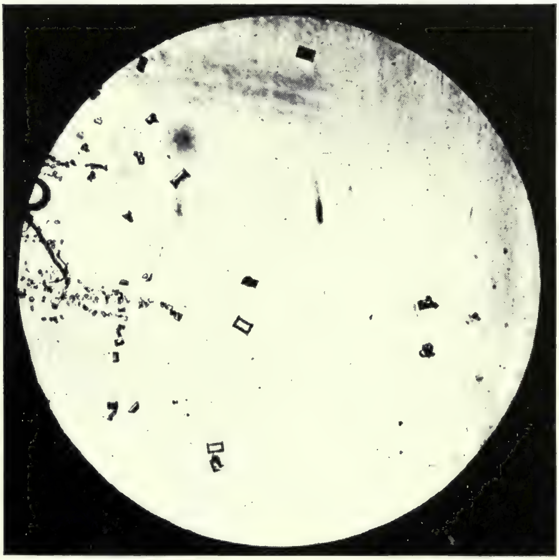


FIG. 2

PLATE XIX

FIG. 1. Ammonio-Magnesium Phosphate. $(NH_4)MgPO_4$.
(Triple Phosphate.)

FIG. 2. Ammonium Phosphate. $(NH_4)_2HPO_4$.

PLATE XIX

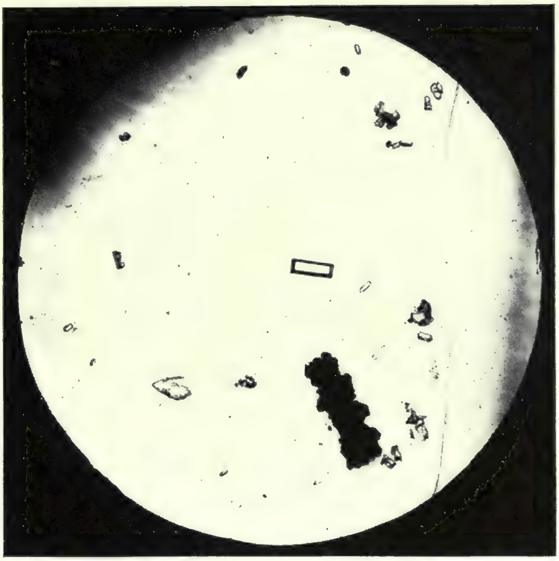


FIG. 1

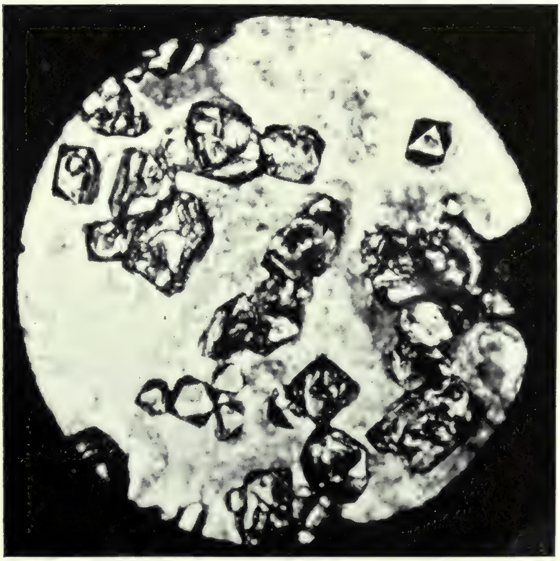


FIG. 2

PLATE XX

FIG. 1. Acid Sodium Phosphate. H_2NaPO_4.

FIG. 2. Acid Sodium Phosphate. H_2NaPO_4.

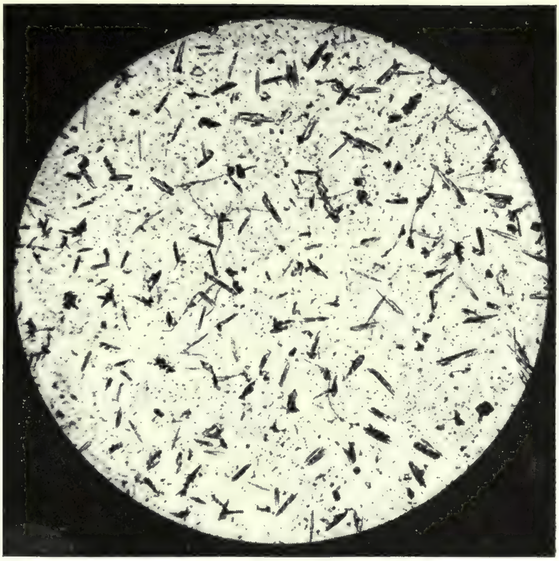


FIG. 1

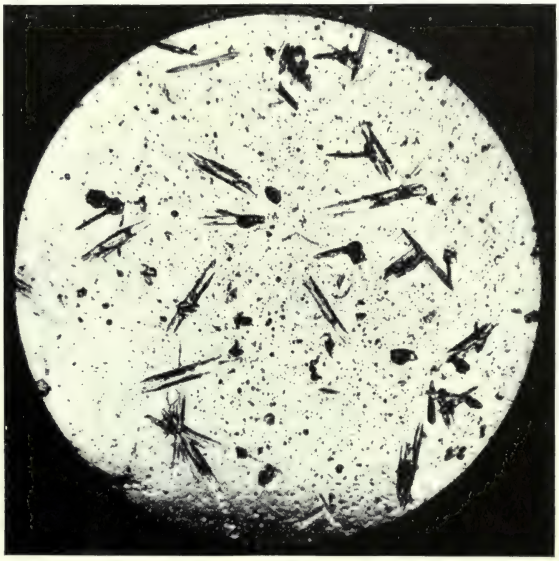


FIG. 2

PLATE XXI

Fig. 1. Acid Sodium Phosphate. $HNa_2PO_4.H_2O$.
(Polarized Light.)

Fig. 2. Magnesium Phosphate. $MgPO_4$.

PLATE XXI

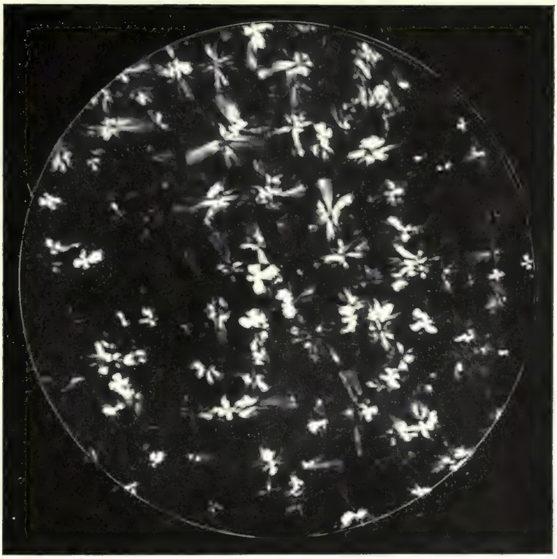


FIG. 1

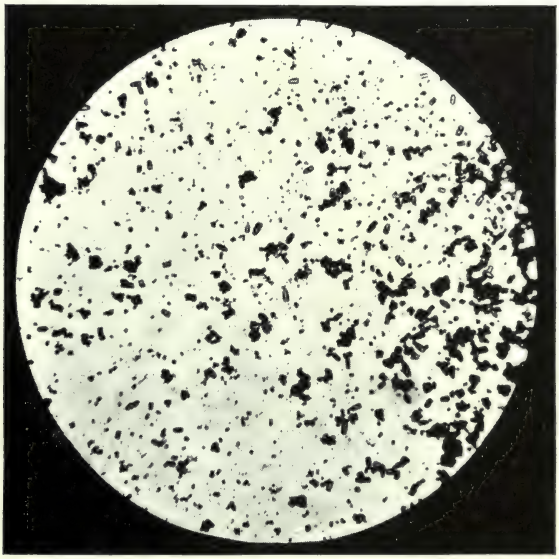


FIG. 2

PLATE XXII

FIG. 1. Potassium Carbonate. K_2CO_3.

FIG. 2. Acid Carbonate of Soda. $NaHCO_3$.
(Bicarbonate of Soda.)

PLATE XXII

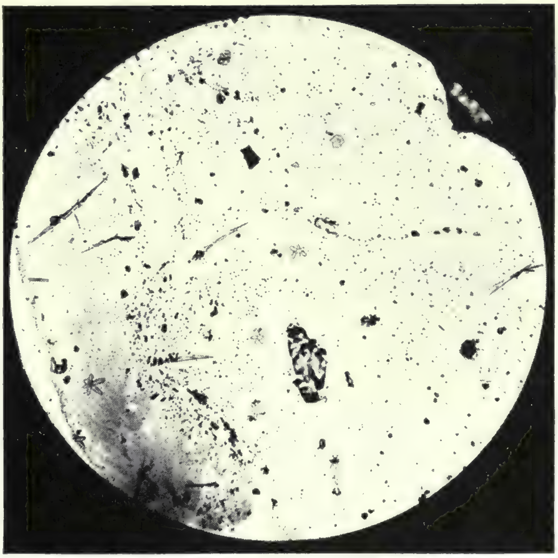


Fig. 1

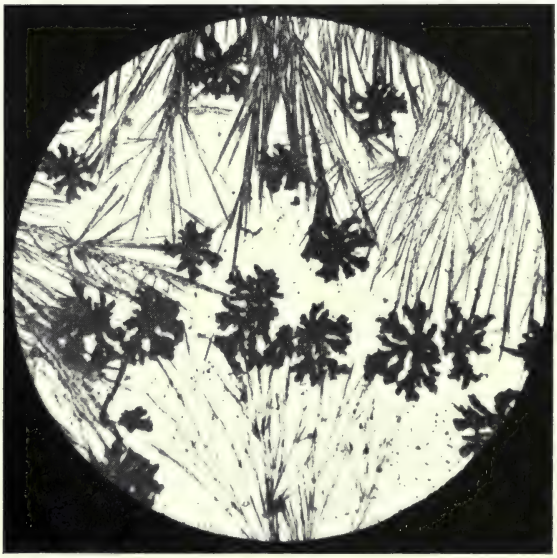


Fig. 2

PLATE XXIII

FIG. 1. Sodium Nitrate. $NaNO_3$.

FIG. 2. Sodium Nitrate. $NaNO_3$.

PLATE XXIII

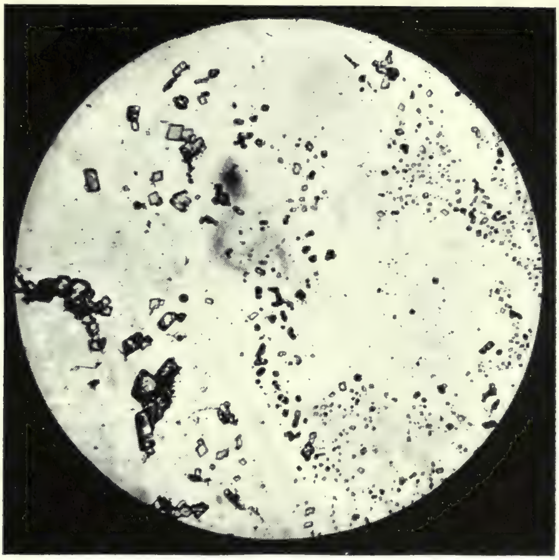


FIG. 1

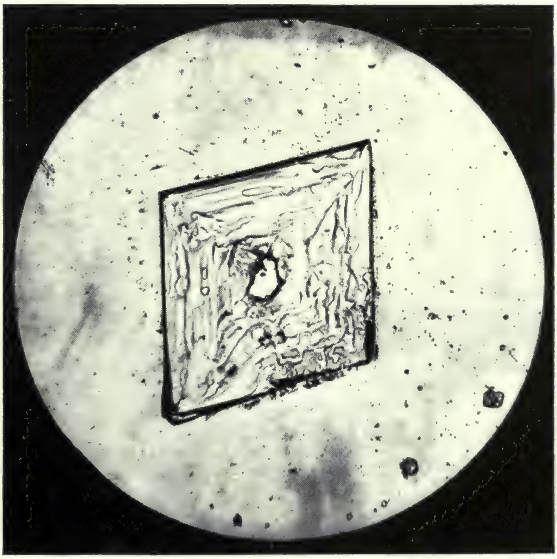


FIG. 2

PLATE XXIV

Fig. 1. Urea Nitrate. $CON_2H_4.HNO_3$.

Fig. 2. Ammonium Oxalate. $NH_4C_2O_4$.

PLATE XXIV

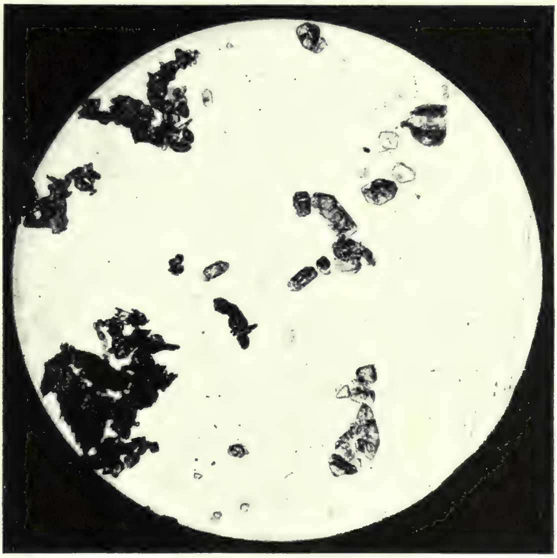


FIG. 1

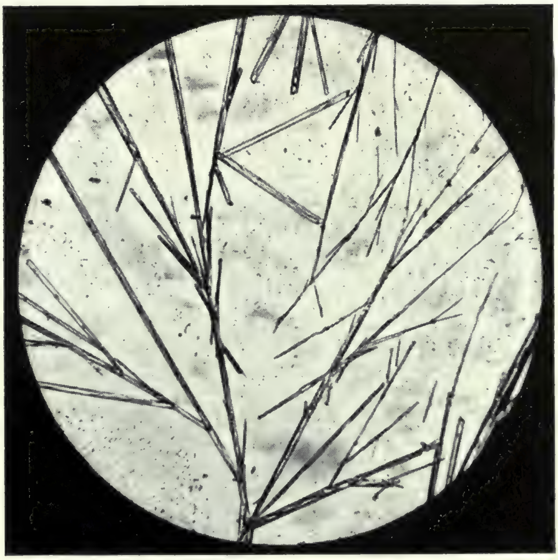


FIG. 2

PLATE XXV

FIG. 1. Sodium Oxalate. NaC_2O_4.

FIG. 2. Sodium Oxalate. NaC_2O_4.

PLATE XXV

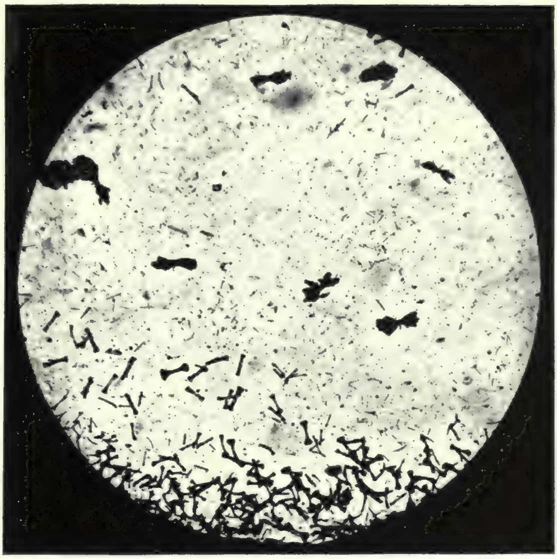


FIG. 1

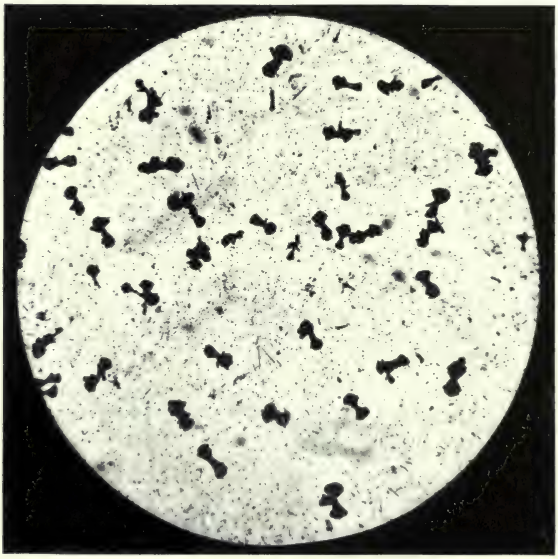


FIG. 2

PLATE XXVI

Fig. 1. Potassium Oxalate. $K_2C_2O_4$.

Fig. 2. Calcium Oxalate. CaC_2O_4.

PLATE XXVI

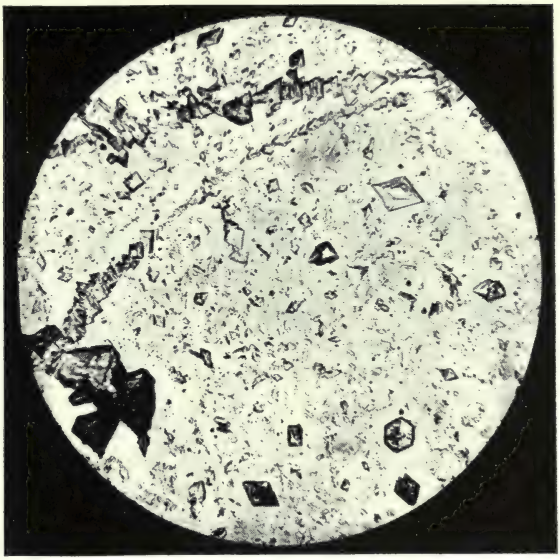


Fig. 1

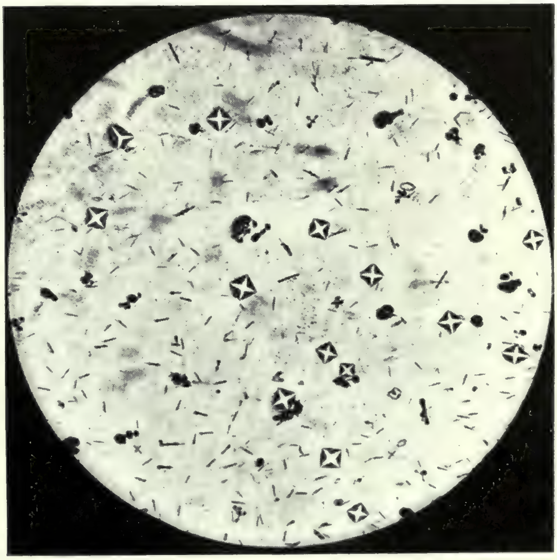


Fig. 2

PLATE XXVII

Fig. 1. Ammonium Bromid. $(NH_4)Br$.

Fig. 2. Potassium Bromid. KBr.

PLATE XXVII

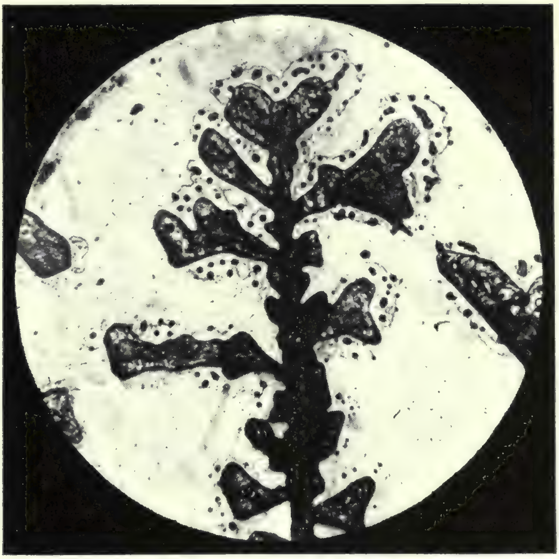


FIG. 1

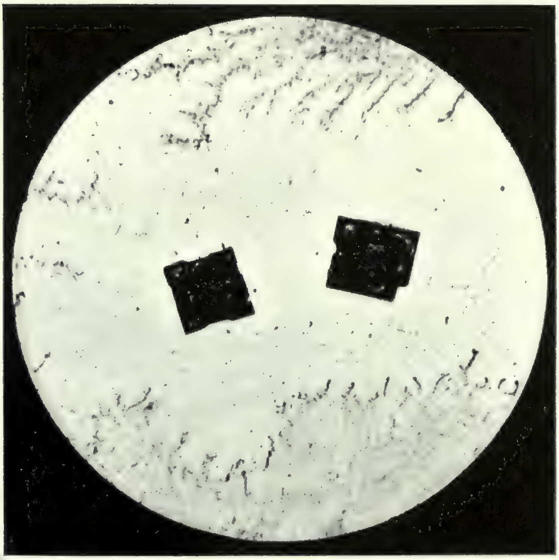


FIG. 2

PLATE XXVIII

FIG. 1. Sodium Bromid. NaBr.

FIG. 2. Sodium Bromid. NaBr.

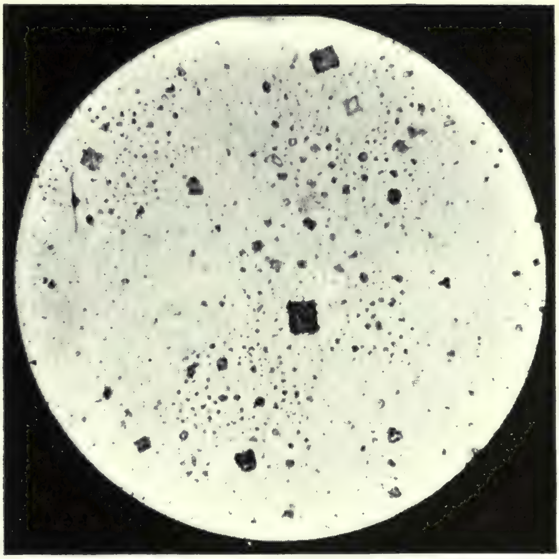


Fig. 1

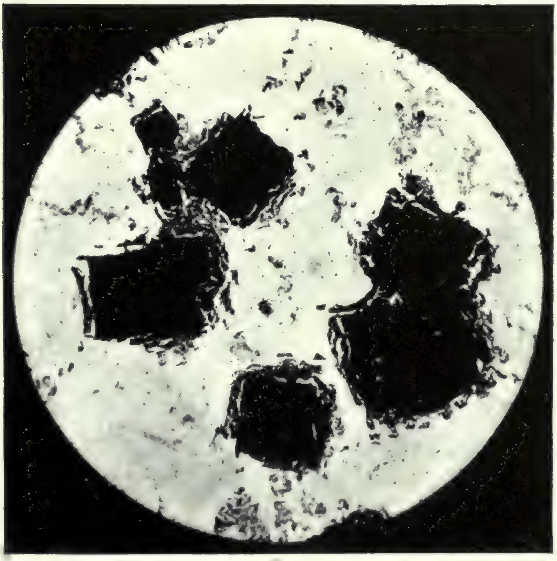


Fig. 2

PLATE XXIX

Fig. 1. Ammonium Iodid. NH_4I.

Fig. 2. Ammonium Iodid. NH_4I.

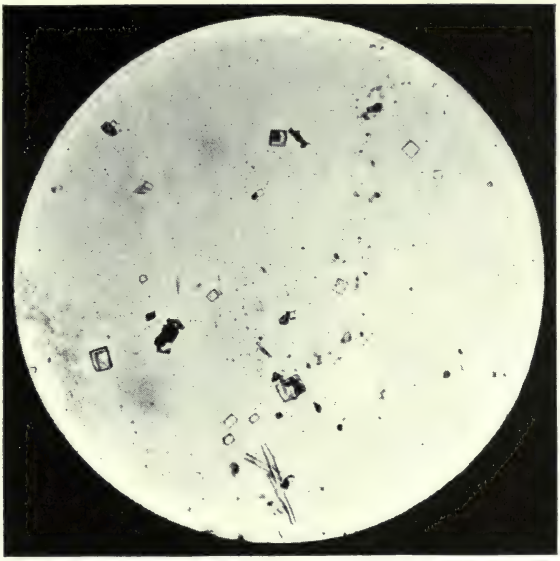


FIG. 1

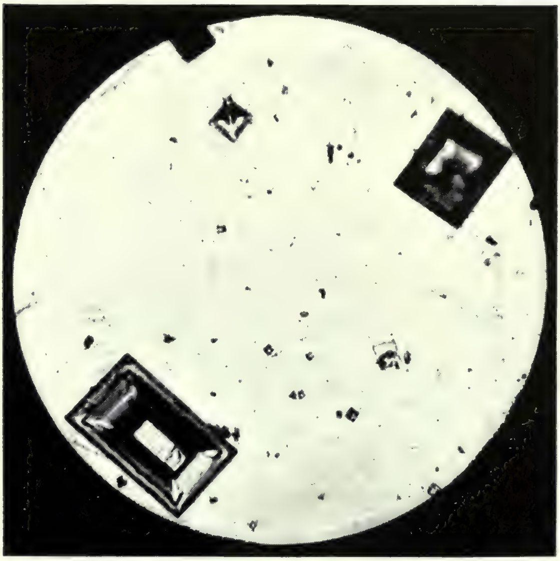


FIG. 2

PLATE XXX

FIG. 1. Potassium Iodid. KI.

FIG. 2. Cystin. $C_6H_{12}O_4N_2S_2$.

PLATE XXX

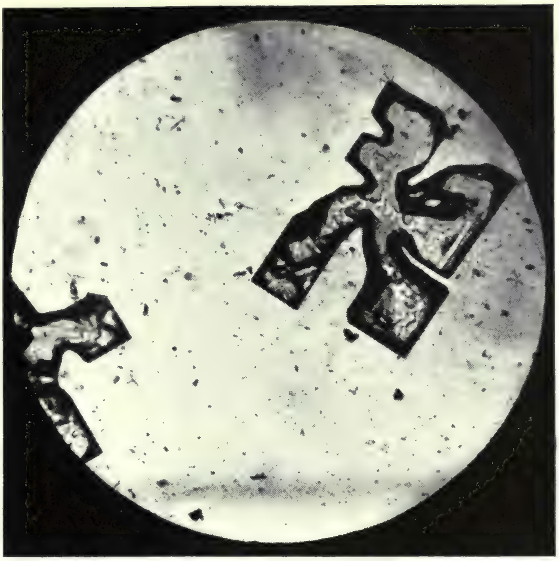


Fig. 1

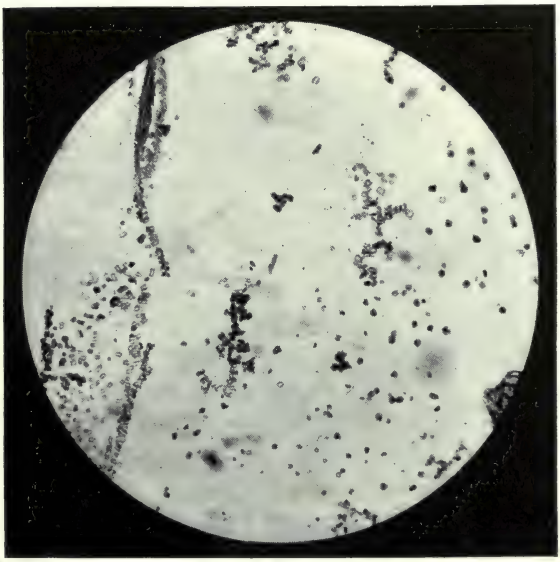


Fig. 2

PLATE XXXI

FIG. 1. Cystin. $C_6H_{12}O_4N_2S_2$.

FIG. 2. Cystin. $C_6H_{12}O_4N_2S_2$.

PLATE XXXI

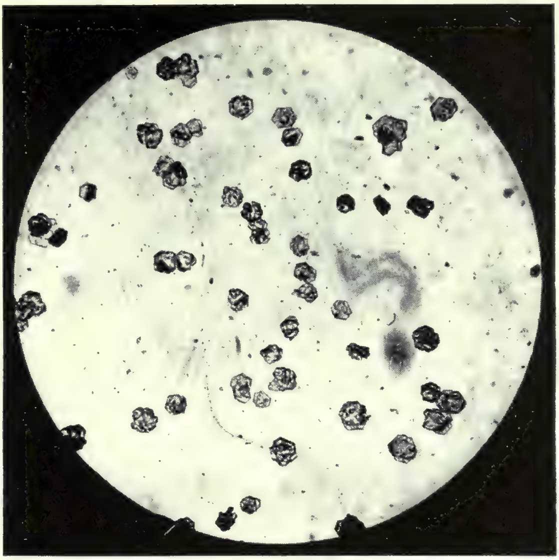


Fig. 1

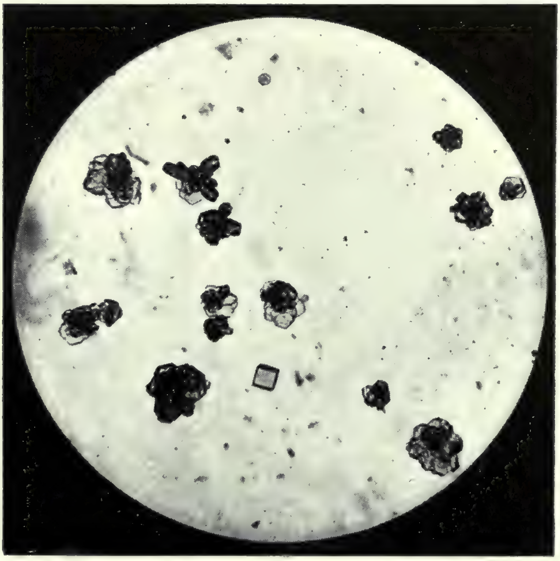


Fig. 2

PLATE XXXII

FIG. 1. Sodium Urate. $C_5H_3N_4O_3Na$.
(Low Power.)

FIG. 2. Sodium Urate. $C_5H_3N_4O_3Na$.
(High Power.)

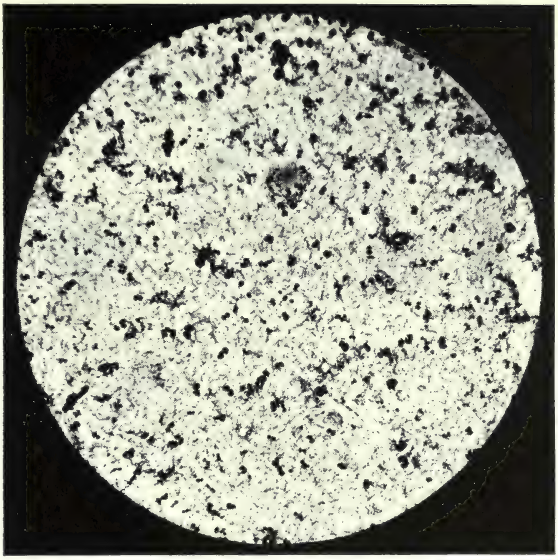


FIG. 1

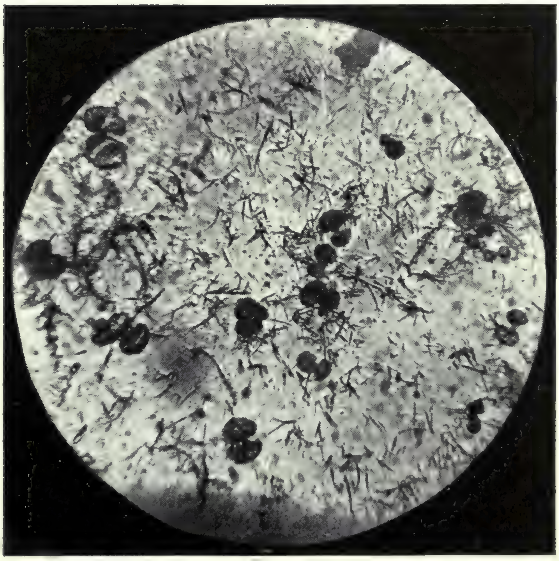


FIG. 2

PLATE XXXIII

Fig. 1. Creatinine. $C_4H_7N_3O$.

Fig. 2. Creatinine. $C_4H_7N_3O$.

PLATE XXXIII

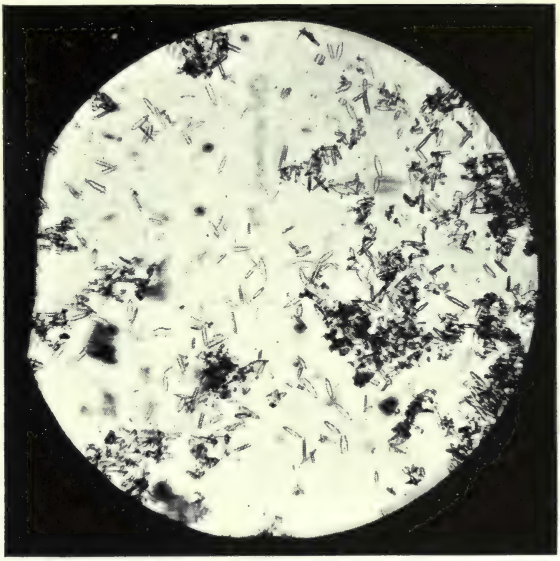


FIG. 1

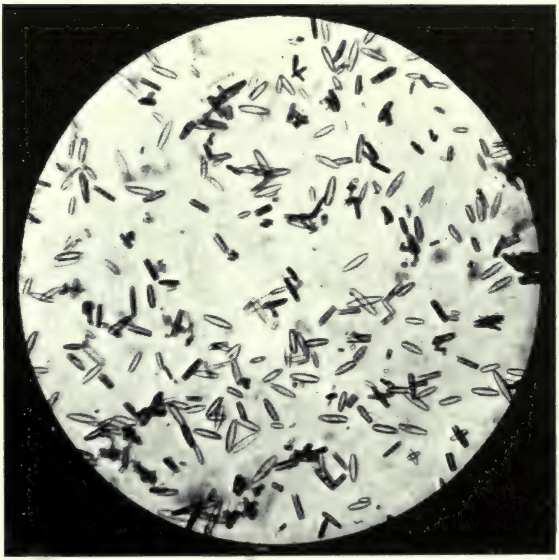


FIG. 2

PLATE XXXIV

Fig. 1. Magnesium Lactate.

Fig. 2. Lactose. $C_{12}H_{24}O_{12}$.
(Milk-sugar.)

PLATE XXXIV

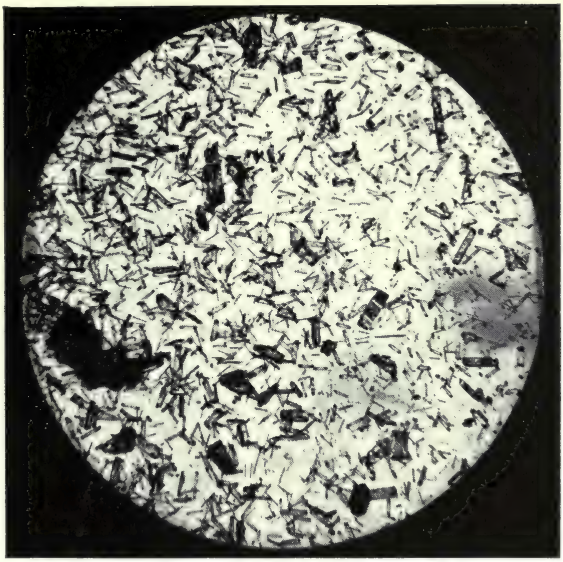


FIG. 1

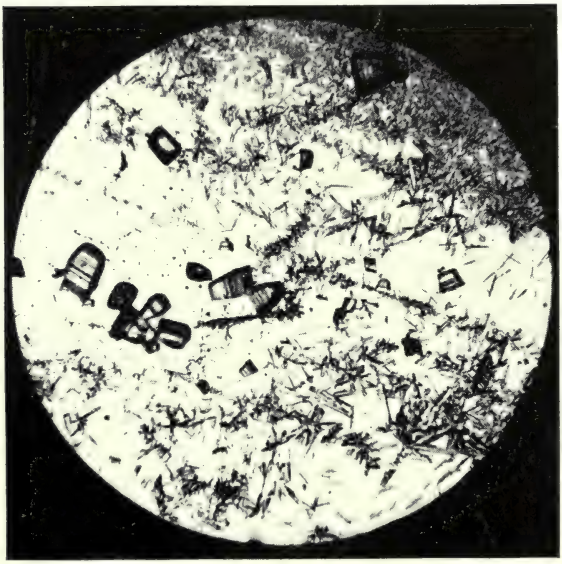


FIG. 2

PLATE XXXV

FIG. 1. Saccharose. $C_{12}H_{22}O_{11}$.
(Cane-sugar.)

FIG. 2. Potassium Nitrate. KNO_3.

PLATE XXXV

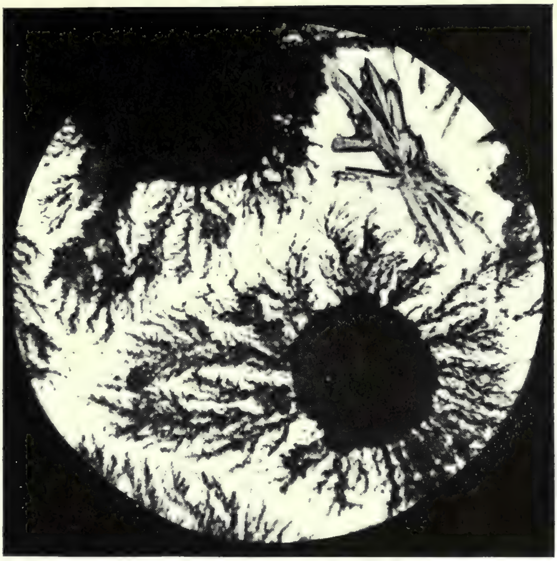


Fig. 1

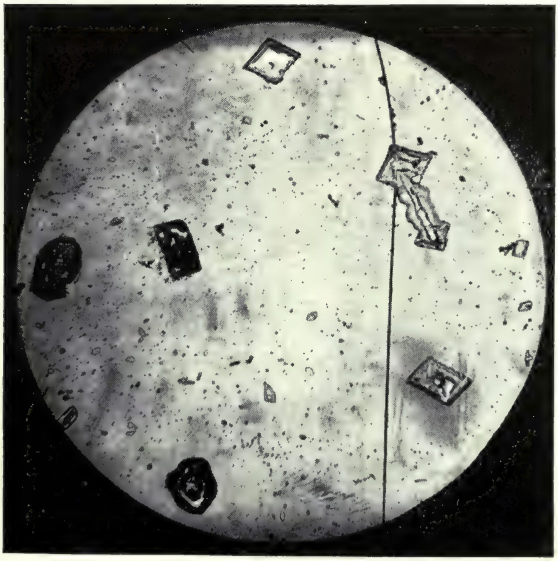


Fig. 2

PLATE XXXVI

Fig. 1. Uric Acid. $C_5H_4N_4O_3$.
(Needles.)

Fig. 2. Uric Acid. $C_5H_4N_4O_3$.
(Plates.)

PLATE XXXVI

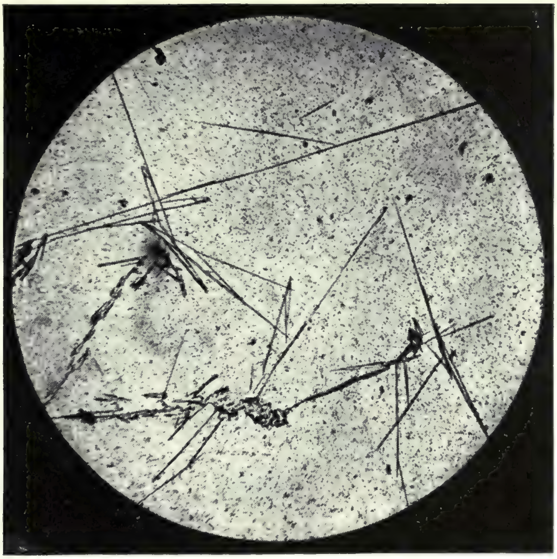


FIG. 1

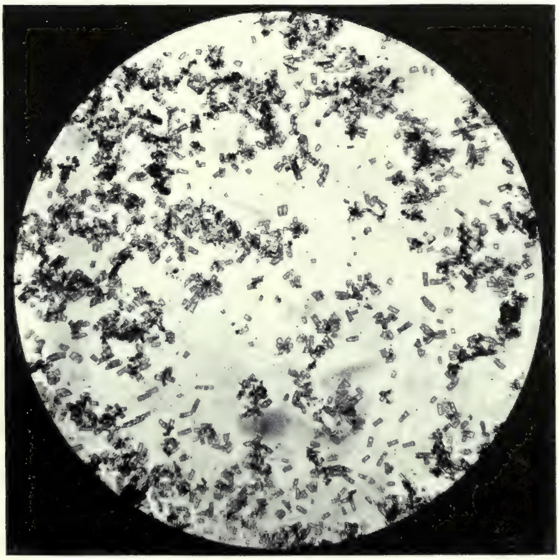


FIG. 2

PLATE XXXVII

FIG. 1. Cholesterin. $C_{26}H_{43}OH$.

FIG. 2. Caffeine. $C_8H_{10}N_4O_2.H_2O$.

PLATE XXXVII

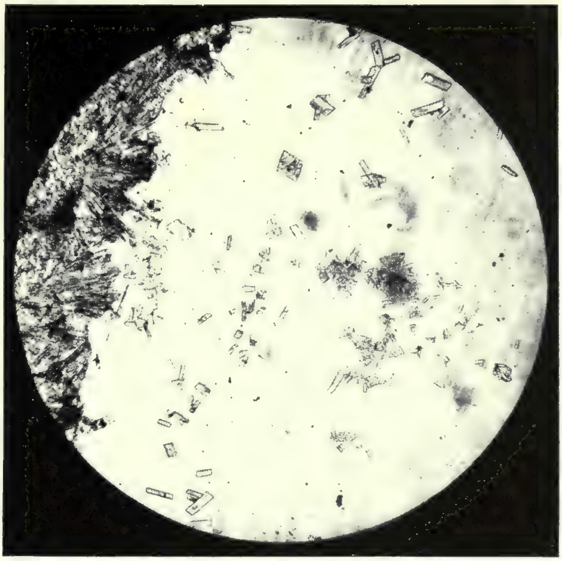


FIG. 1

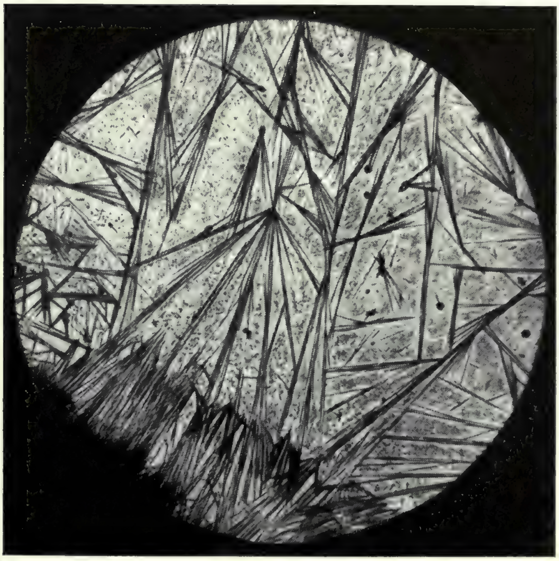


FIG. 2

PLATE XXXVIII

Fig. 1. Urea. CON_2H_4.

Fig. 2. Hippuric Acid. $C_9H_9NO_3$.

PLATE XXXVIII

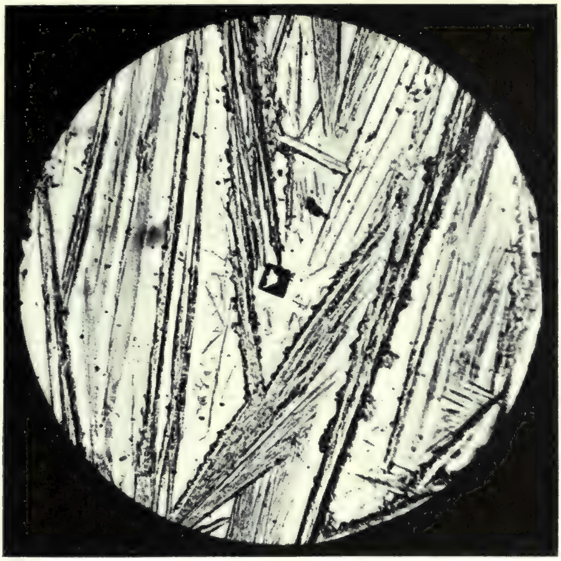


FIG. 1

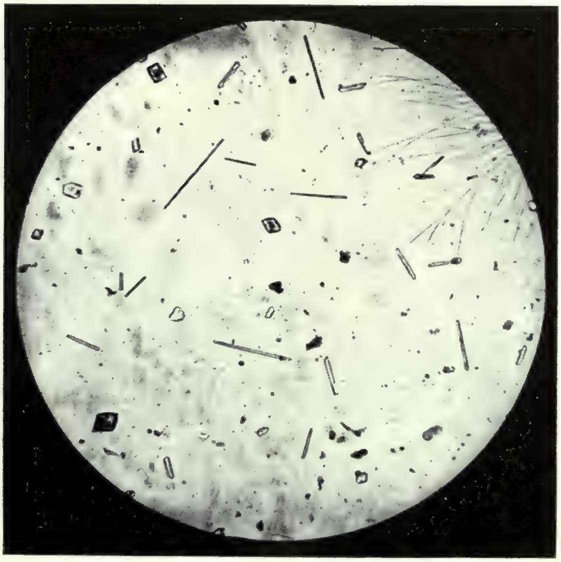


FIG. 2

PLATE XXXIX

FIG. 1. Hippuric Acid. $C_9H_9NO_3$.

FIG. 2. Glycocol. $C_2H_5NO_2$.
(Gelatin-sugar.)

PLATE XXXIX

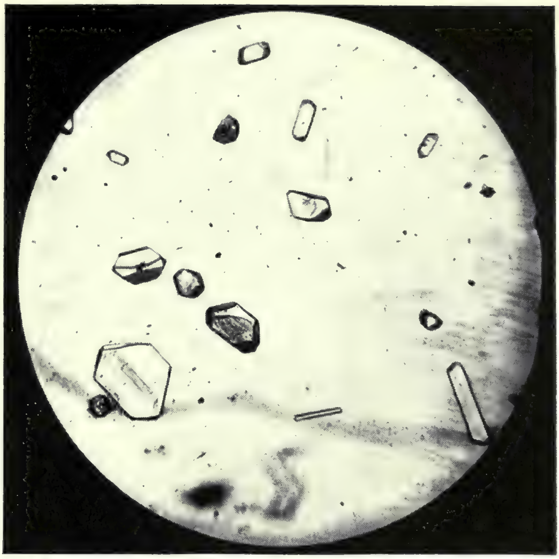


Fig. 1

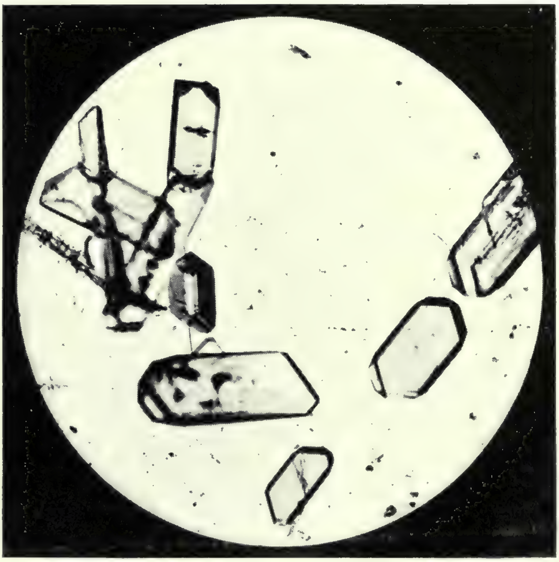


Fig. 2

PLATE XL

FIG. 1. Calcium Chloride and Sodium Phosphate.

FIG. 2. Calcium Chloride and Acid Sodium Phosphate.

PLATE XL

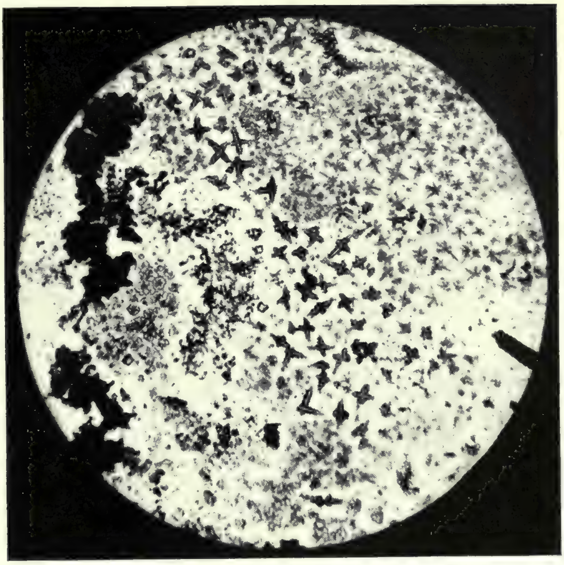


Fig. 1

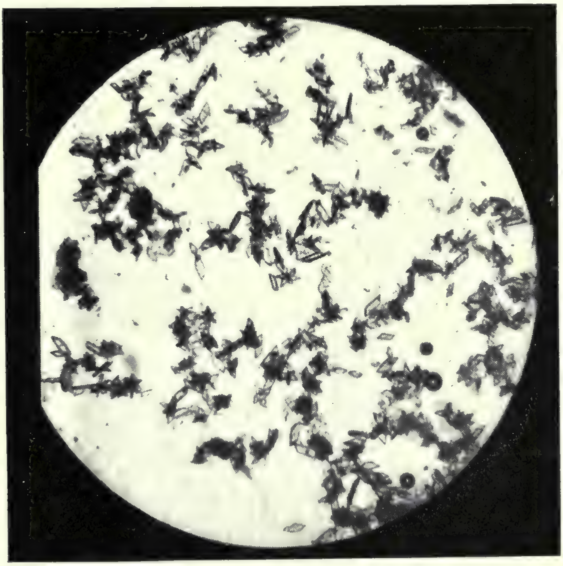


Fig. 2

PLATE XLI

FIG. 1. Calcium Sulphate and Sodium Chloride.

FIG. 2. Calcium Sulphate and Sodium Chloride.

PLATE XLI

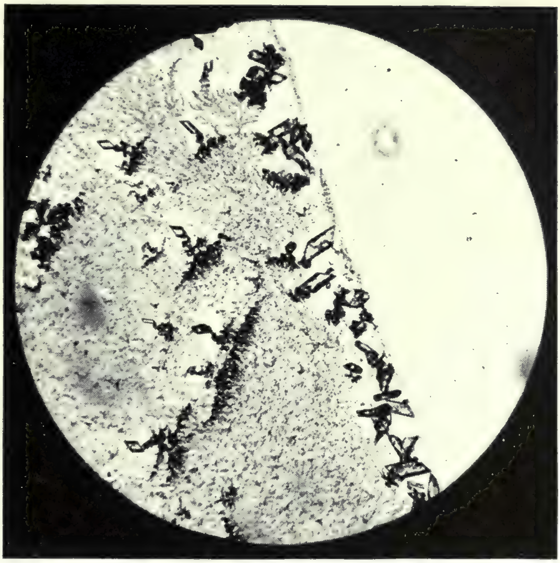


FIG. 1

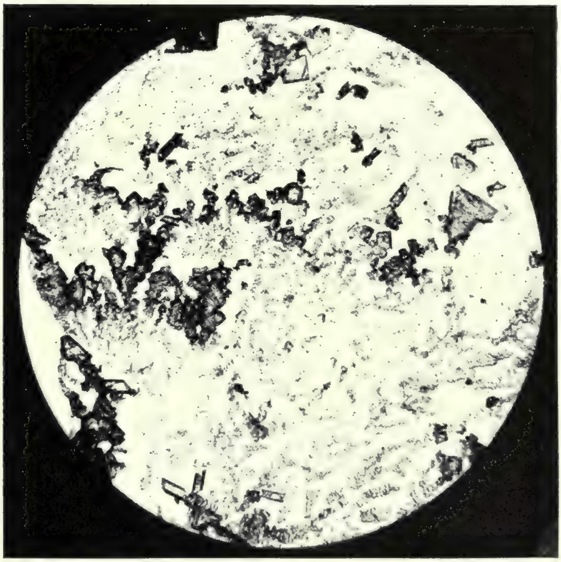


FIG. 2

PLATE XLII

Fig. 1. Calcium Sulphate and Sodium Chloride.

Fig. 2. Lactose and Sodium Chloride.

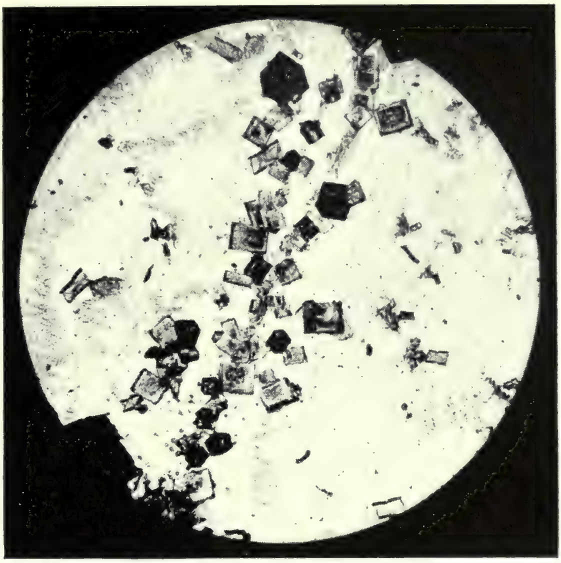


FIG. 1

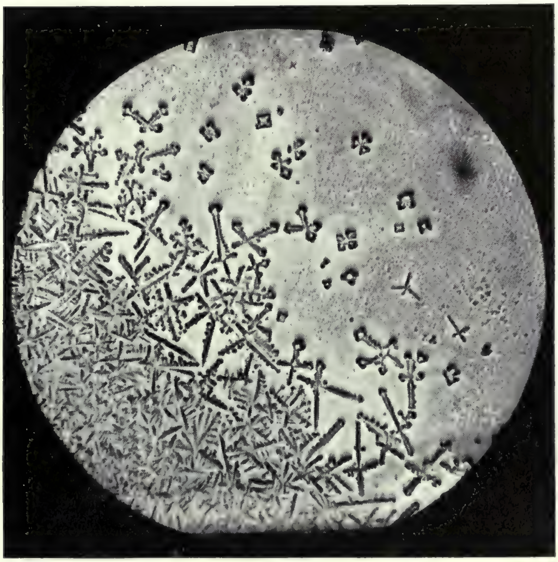


FIG. 2

PLATE XLIII

FIG. 1. Maltose and Sodium Chloride.

FIG. 2. Glucose and Sodium Chloride.

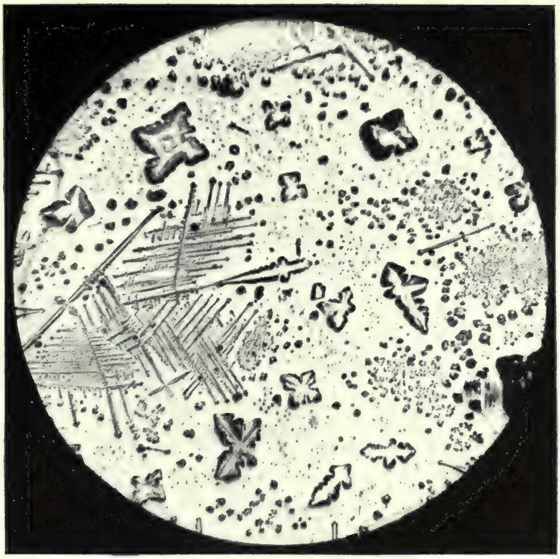


FIG. 1

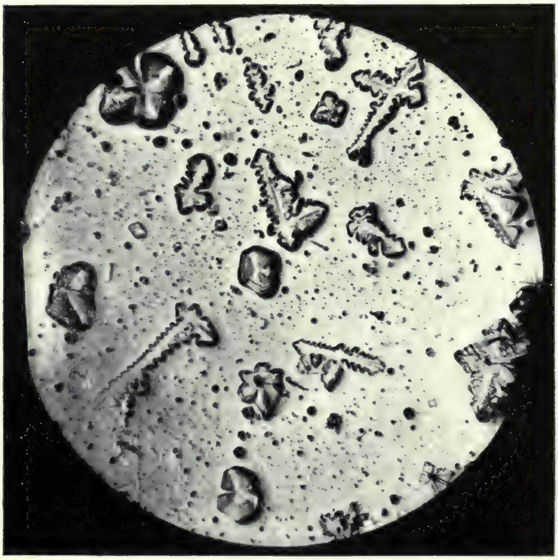


FIG. 2

PLATE XLIV

FIG. 1. Calcium Chloride and Oxalic Acid.
(36 hours' evaporation.)

FIG. 2. Magnesium Chloride and Acid Sodium Phosphate.

PLATE XLIV

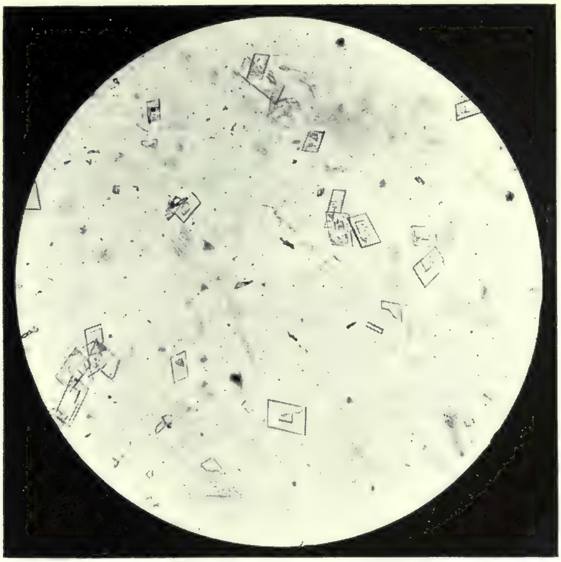


Fig. 1

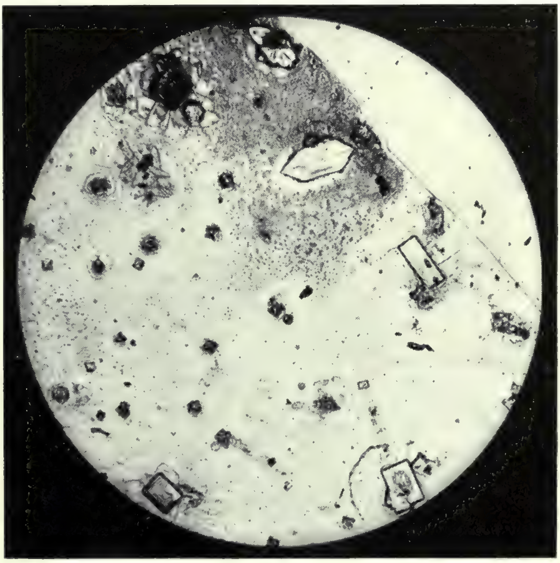


Fig. 2

PLATE XLV

FIG. 1. Sodium Nitrate and Ammonium Chloride.

FIG. 2. Sodium Nitrate and Calcium Chloride.

PLATE XLV

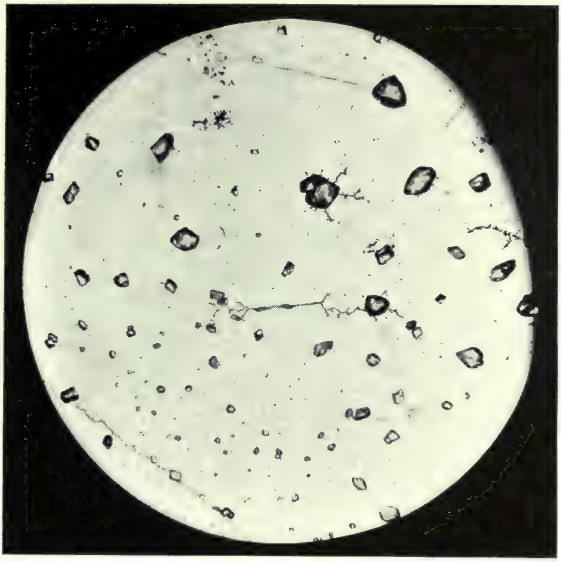


Fig. 1

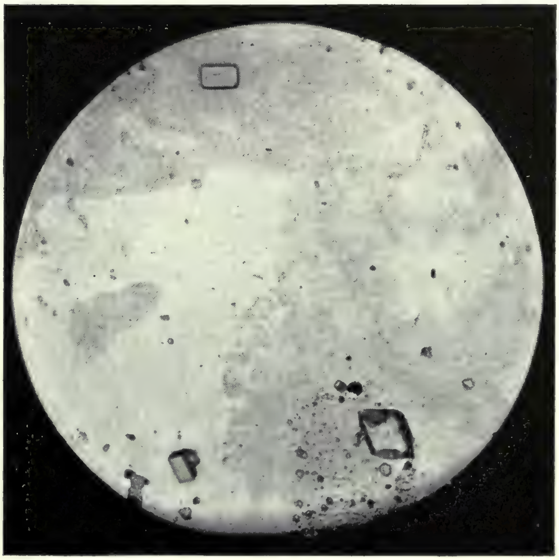


Fig. 2

PLATE XLVI

Fig. 1. Sodium Sulphate and Calcium Chloride.

Fig. 2. Ammonium Sulphate and Magnesium Chloride.

PLATE XLVI

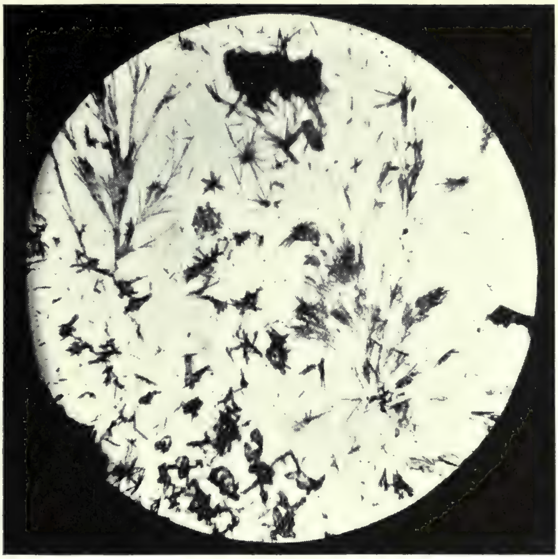


FIG. 1

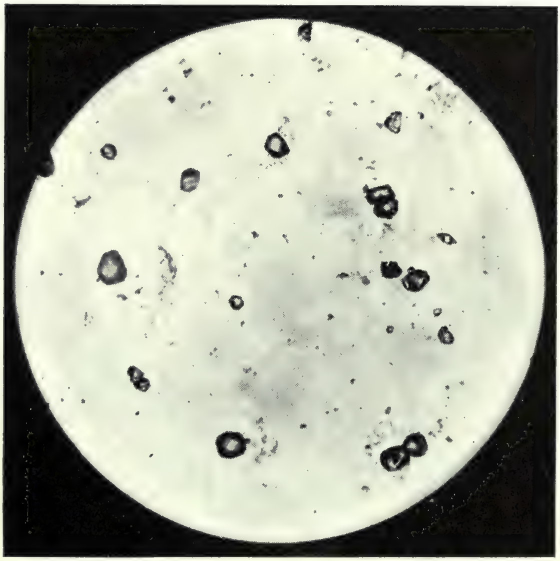


FIG. 2

PLATE XLVII

Fig. 1. Ammonium Sulphate and Calcium Chloride.

Fig. 2. Ammonium Sulphate and Potassium Chloride.

PLATE XLVII

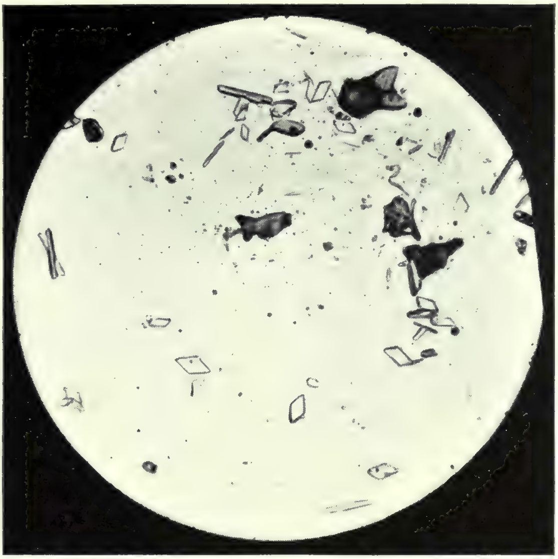


FIG. 1

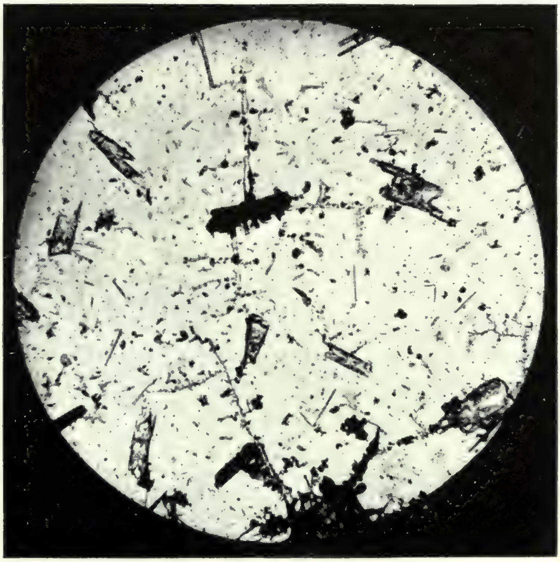


FIG. 2

PLATE XLVIII

Fig. 1. Calcium Sulphate and Sodium Chloride.

Fig. 2. Potassium Ferricyanide.

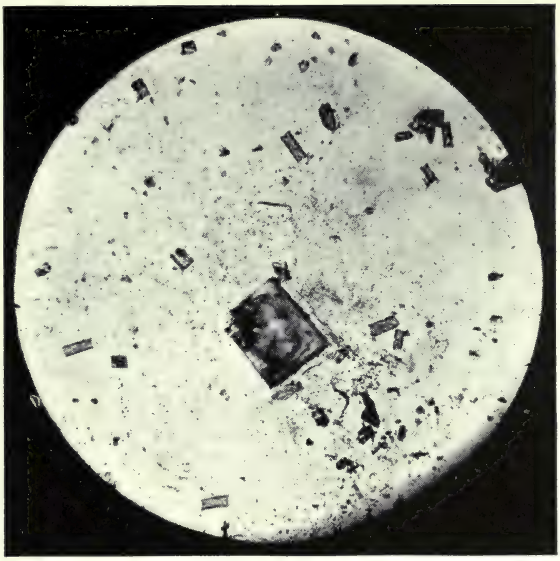


Fig. 1

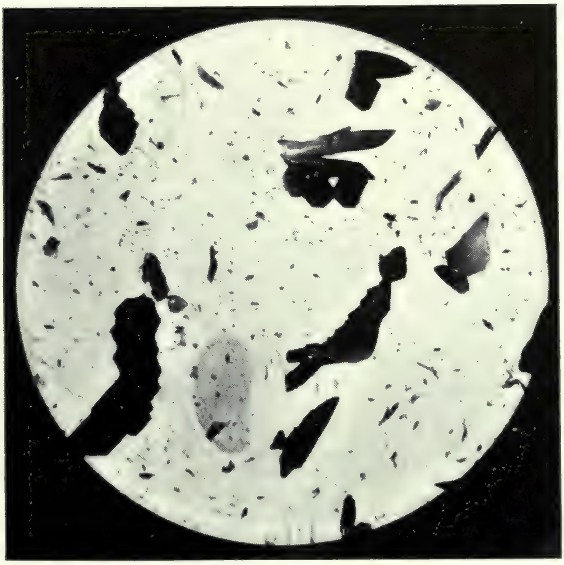


Fig. 2

PLATE XLIX

FIG. 1. Sodium Lactophosphate.

FIG. 2. Sodium Nitroprussiate.

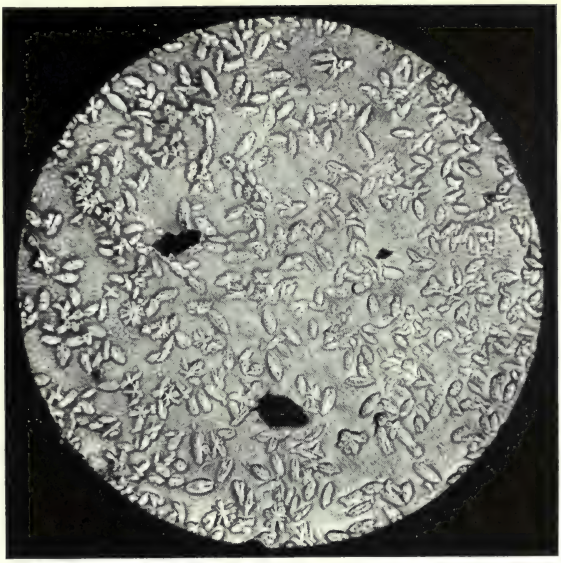


FIG. 1

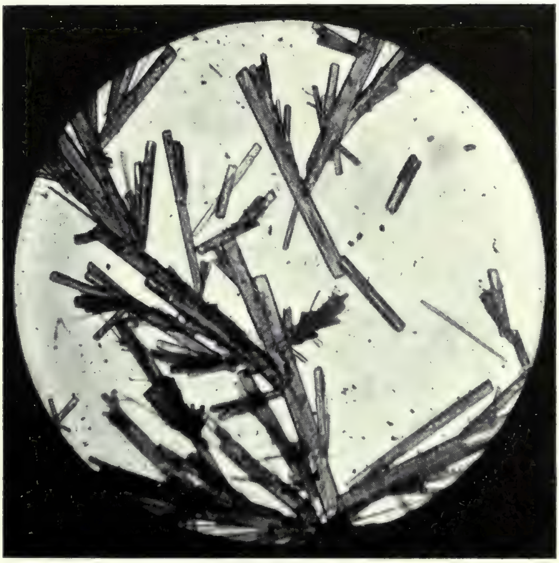


FIG. 2

PLATE L

Fig. 1. Gallic Acid.

Fig. 2. Gallic Acid.

PLATE L

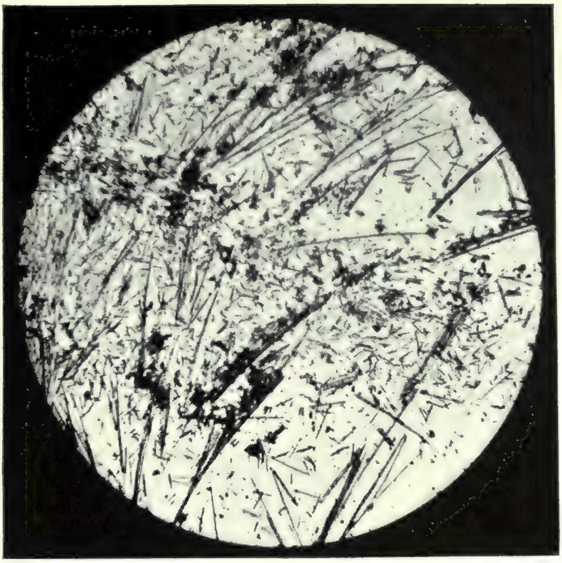


Fig. 1

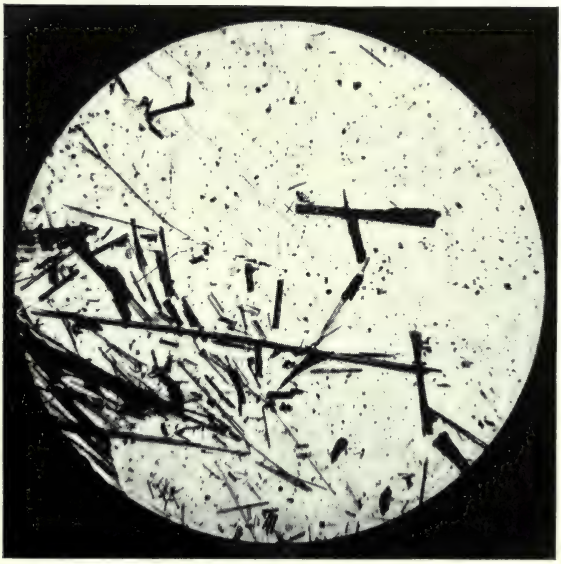


Fig. 2

PLATE LI

Fig. 1. Potassium Bichromate.

Fig. 2. Lead Acetate.

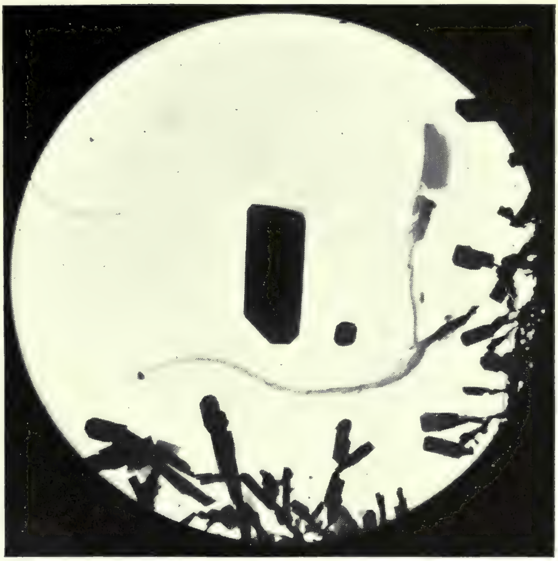


FIG. 1

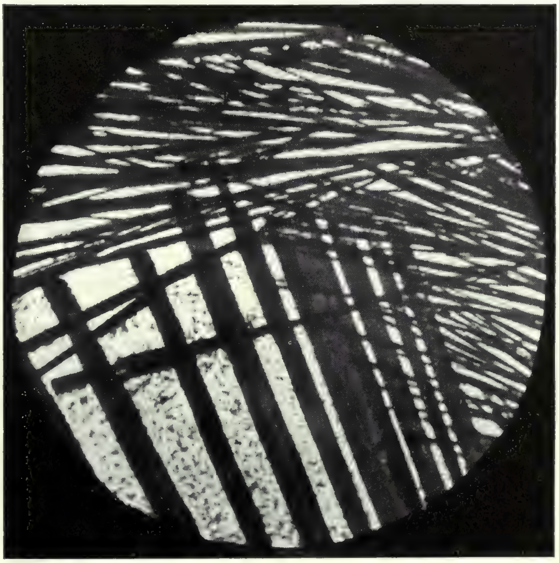


FIG. 2

PLATE LII

Fig. 1. Mercuric Cyanide.

Fig. 2. Mercuric Cyanide.

PLATE LII

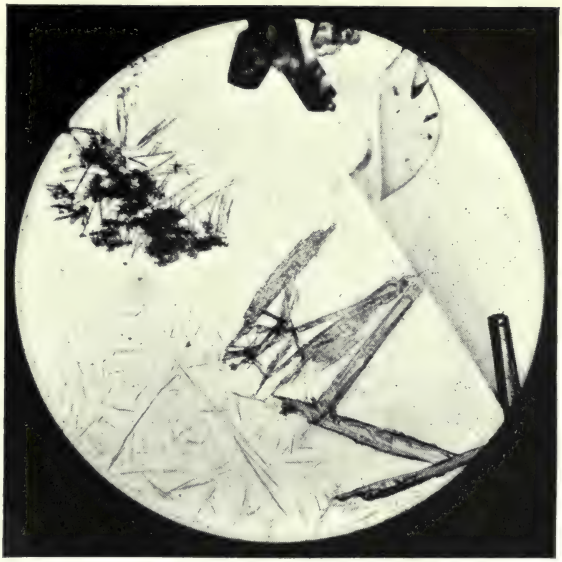


FIG. 1

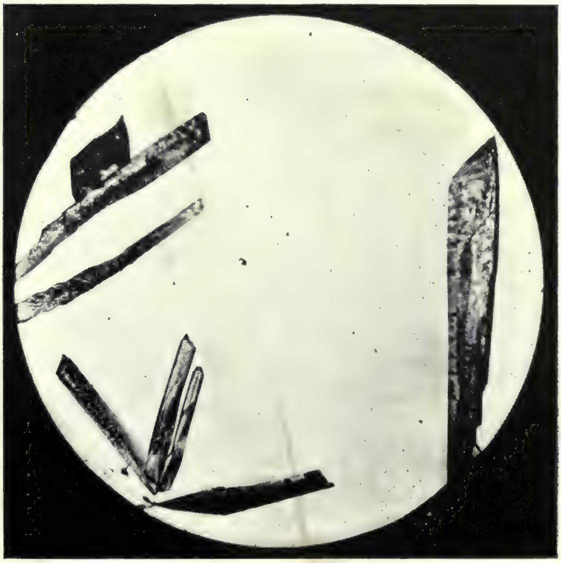


FIG. 2

PLATE LIII

Fig. 1. Arsenic Trioxide.
(Low Power.)

Fig. 2. Arsenic Trioxide.
(High Power.)

PLATE LIII

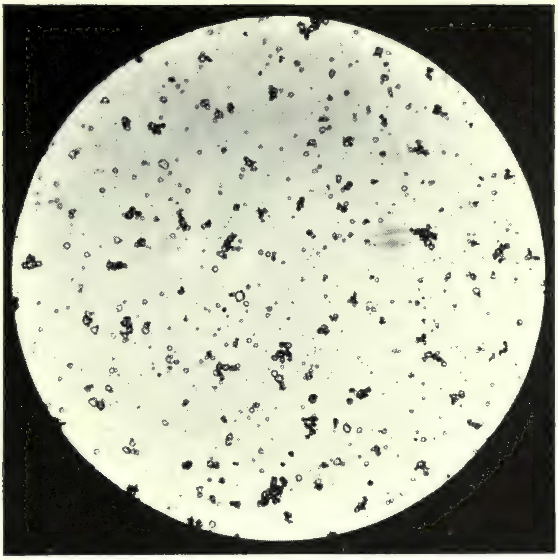


FIG. 1

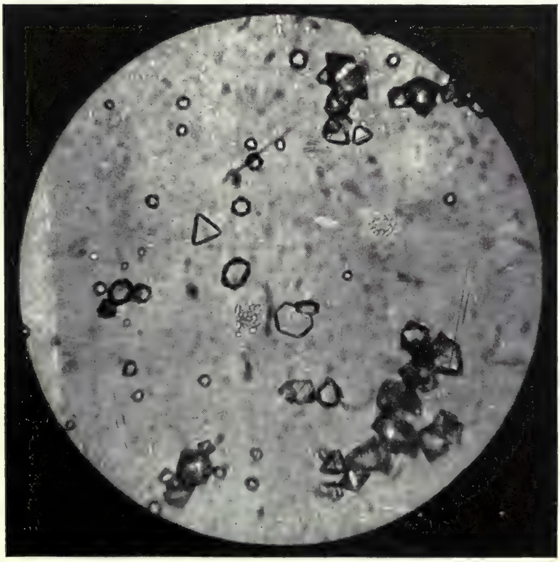


FIG. 2

PLATE LIV

FIG. 1. Potassium and Sodium Tartrate.
(Rochelle Salt.)

FIG. 2. Potassium Alum.

PLATE LIV

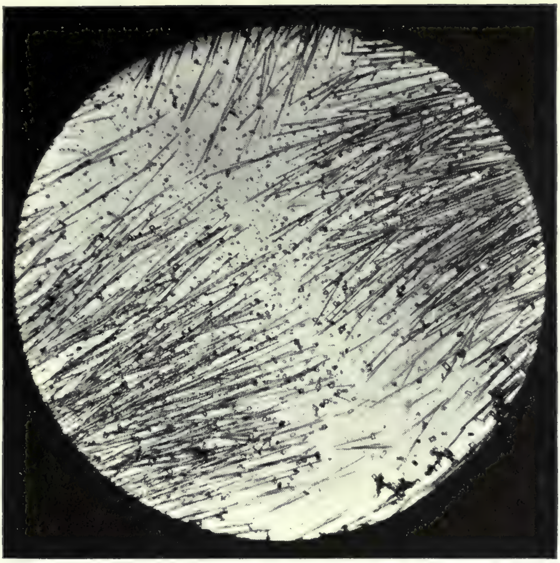


FIG. 1

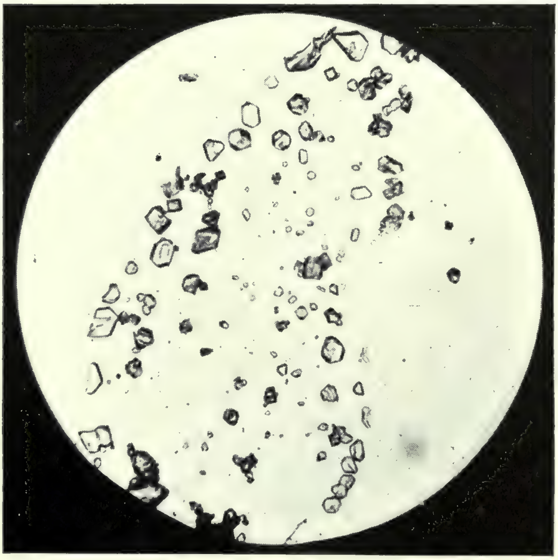


FIG. 2

PLATE LV

FIG. 1. Sugar from Concord Grape Juice. (Dialized.)

FIG. 2. Starch from Potato.

PLATE LV

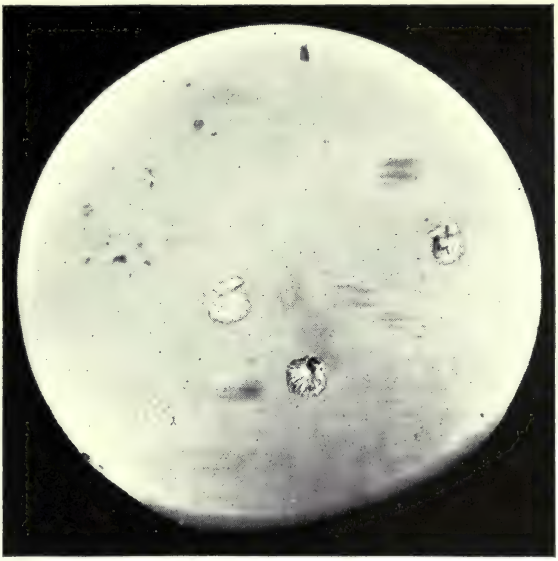


FIG. 1

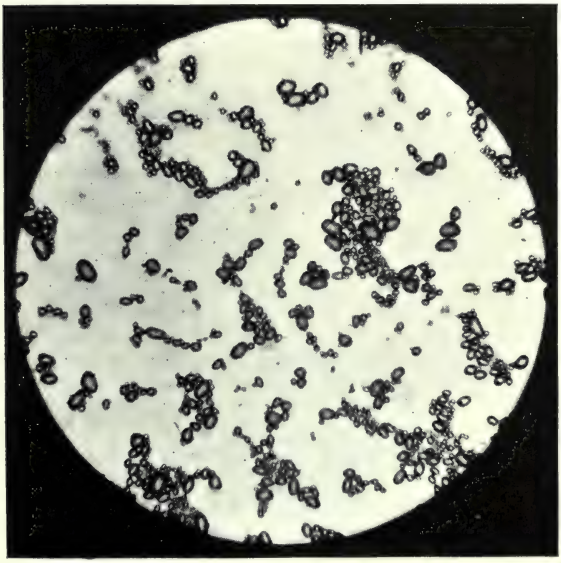


FIG. 2

PLATE LVI

Fig. 1. Potassium Ferrocyanide.

Fig. 2. Potassium Ferrocyanide.

PLATE LVI

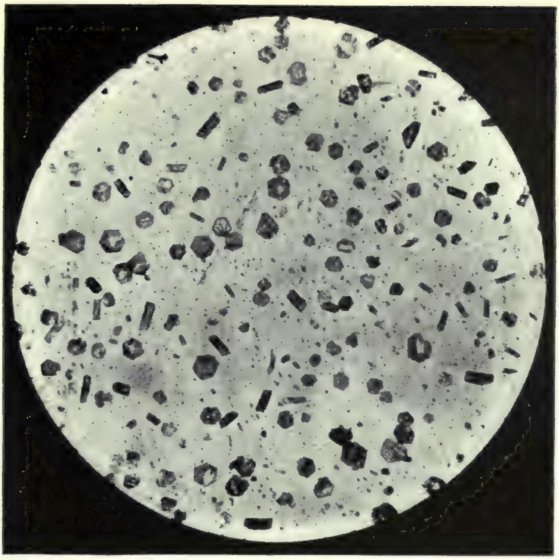


FIG. 1

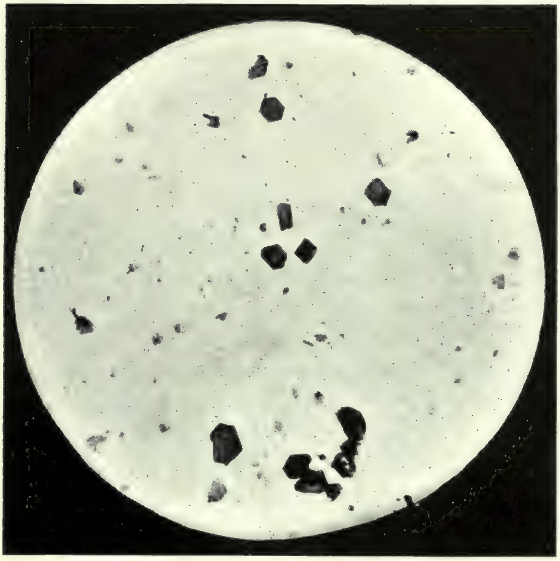


FIG. 2

PLATE LVII

Fig. 1. Sodium Chlorate.

Fig. 2. Potassium Chlorate.

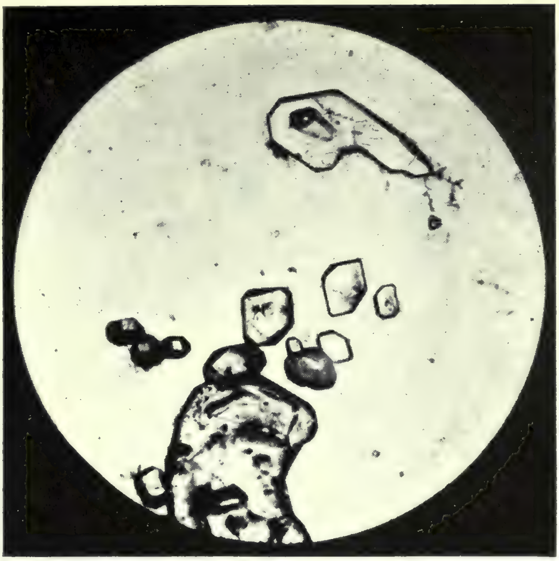


FIG. 1

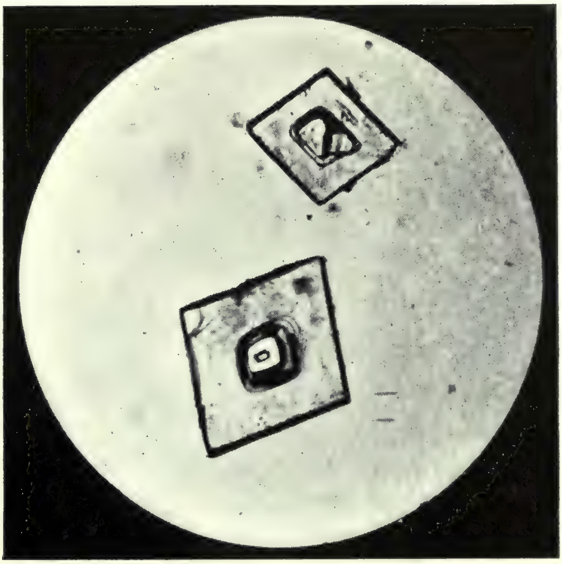


FIG. 2

CRYSTALLIZATION

Crystals possess no organs as do plants and animals, and therefore go through no similar stages of growth, but by accretion.

The habit of a crystal is expressed by its tendency to grow more rapidly in certain directions than in others; as a limited growth in one direction making a flat or *tabular* habit, which may be either thick or thin; also cases which grow largely in one direction, making a *prismatic* habit.

More extreme cases present needle-like or *acicular* crystals, or *capillary* crystals, resembling fine hairs, while other habits may be termed Cubic, Pyramidal, Octahedral, Dendritic, etc.

During very rapid growth crystals may be produced having a hollow form, which are sometimes called Skeleton Crystals.

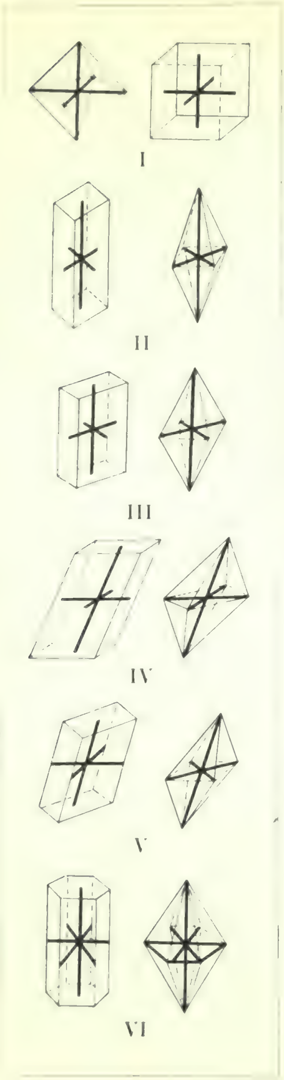
Crystallographers seem quite agreed that the modern classification of crystals is based upon symmetry, as only axes of two, three, four and sixfold symmetry have ever been found on crystals.

Going still further they demonstrate that it is impossible, thus limited, to produce more than thirty-two combinations of symmetry elements.

It is also a fact that included in these thirty-two groups or classes there are six from which the other twenty-six may be derived, and we therefore reduce the total to six systems into which all crystals may be grouped, and as generally recognized they are as follows:

Six Systems of Crystallization

I. Monometric or Regular System: Three equal axes intersecting each other at right angles. Includes cube, regular octahedron, rhombic dodecahedron, and other perfectly symmetrical forms.



II. Dimetric or Quadratic System: Three axes intersecting each other at right angles, one axis longer or shorter than the other two, which are equal. Includes right square prism, and octahedron with a square base.

III. Trimetric or Rhombic System: Three axes intersecting each other at right angles, no two of them being of equal length. Includes the right rectangular prism, the right rhombic prism, and corresponding octahedrons.

IV. Monoclinic System: Three equal axes, one the vertical at right angles to one of the other two, which are called lateral, but obliquely inclined to the other axis. The two lateral axes intersect each other at right angles. Includes oblique rectangular prism, oblique rhombic prism, and corresponding octahedral forms.

V. Triclinic System: Three unequal axes, all intersecting each other at oblique angles. Includes doubly oblique prism and doubly oblique octahedron.

VI. Hexagonal System: Four axes, three lateral axes lying in one plane, of equal length, and intersecting each other at angles of 60°, and a fourth or vertical axis, either longer or shorter than the other three, and crossing them at right angles. Includes the hexagonal prism, hexagonal pyramid, and the rhombohedron.

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